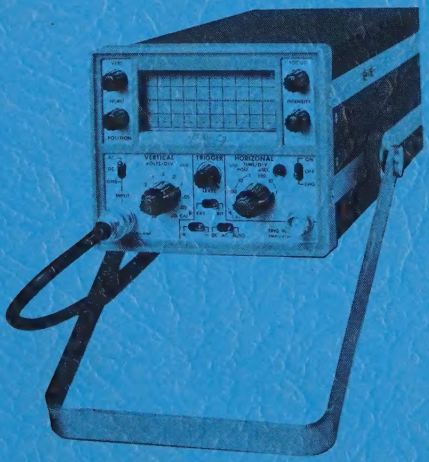
SERIES PS900

MINI-PORTABLE OSCILLOSCOPES



VU-DATA CORPORATION

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TECHNICAL MANUAL

SERIES PS900

MINI-PORTABLE OSCILLOSCOPES

VU-DATA CORPORATION

AUGUST 1, 1973

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LIST OF EFFECTIVE PAGES

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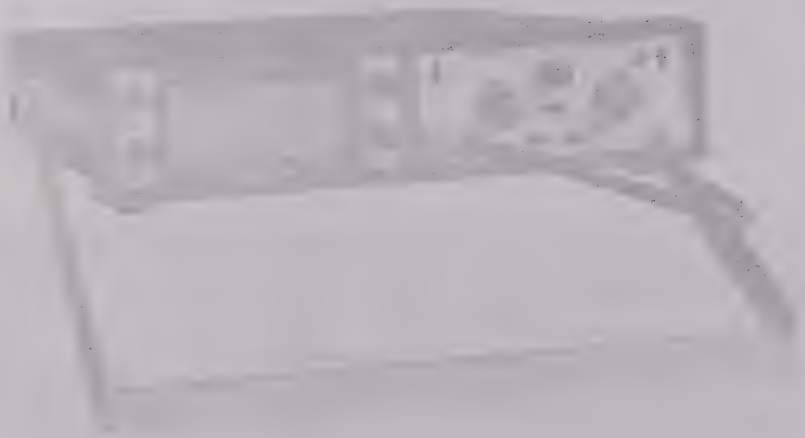
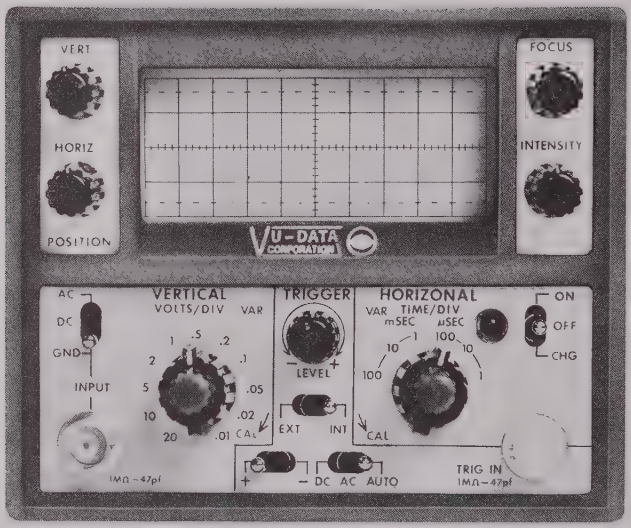
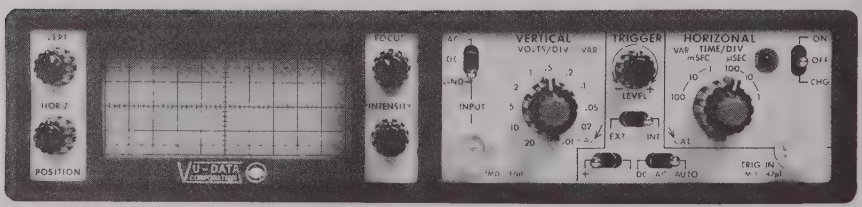
SECTION I

GENERAL DESCRIPTION





Model PS920A



Model PS910A

Figure 1-1. Series PS900 Mini-Portable Oscilloscope

1-1. INTRODUCTION

1-2. This manual contains complete operation, calibration and maintenance instructions for the Series PS900 Mini-Portable Oscilloscope.

1-3. The purpose of this manual is to provide the operation and maintenance information required by the equipment operator or service technician. The manual does not include information pertaining to special equipment applications, nor does it include instructions for accomplishing repairs of the type performed at the factory.

1-4. The manual is divided into eight sections. Section I provides general information regarding the purpose of the equipment, its physical arrangement, and its pertinent specifications. Section II contains information on installation and unpacking. Section III contains instructions for operating the equipment. Section IV describes the theory of operation of the equipment circuits and mechanisms. Section V provides test, alignment, and maintenance procedures. Section VI contains a complete parts list. Section VII contains complete circuit drawings. Section VIII provides a list of recommended spares.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High Voltages, which could be lethal are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The top cover should be removed only for the duration of time required to make the alignments. The power should be off while the cover is being removed or installed.

1-5. PHYSICAL DESCRIPTION

1-6. The Series PS900 Mini-Portable Oscilloscope is available in two versions, which are the Model PS910 "Flatpack" and the PS920 "Stackpack". Both units have the same operating specifications and both may be either bench operated (handle and bezel) or rack mounted. (See Figure 1-2.) .

The PS910 "Flat-Pack" oscilloscope consists of two printed circuit board assemblies mounted side by side which results in a thin profile and allows the instrument to be easily carried in the smallest attache case.

The PS920 "Stack-Pack" oscilloscope consists of the same two printed circuit board assemblies stacked on top of each other, like a sandwich resulting in the small square profile.

1-7. Integrated circuits, silicon semi-conductors, and tantalum capacitors are used to increase reliability. The printed circuit assemblies have all of the principle components identified by reference designator and all diodes and tantalum capacitors are identified for polarity.

1-8. The front panel controls are divided into three basic sections; vertical, horizontal and viewing controls for ease in operation.

1-9. The 1½" x 3" cathode ray tube (CRT) is secured within a metal frame mounted to the front panel, thus bringing the display closer to the front panel to enhance the ease of viewing. A photo-positive graticule, made on clear mylar is inserted in the metal frame between the CRT and the front panel. This eliminates the problem of realigning new tubes when replacement is required.

1-10. APPLICATION

1-11. The Series PS900 "Mini-Portables" are designed to bring laboratory quality to "on-site" DC to 20 MHz oscilloscope test and measurement applications. Their light weight (less than 8 pounds), rugged construction, small size (can fit into a tool kit or brief case) and true portability (can operate from internal batteries) make them indispensible in servicing the sophisticated equipment which today's technology has developed.

Operating power is provided via a detachable AC line cord, or by internal batteries. A choice of rechargeable Nickel-Cadmium or Alkaline battery options is available, and if necessary, even common flashlight batteries can be used. All that is required are eight standard "C" size cells. Internal recharging circuitry and a battery case are included within all units. Furthermore, the battery circuit is fused to interrupt operation in the event Nickel-Cadmium cells which may be installed have reached a discharge level beyond which they would incure permanent damage.

NOTE

Damage to the Series PS900 Mini-Portable Oscilloscope caused by leaky batteries is not covered in Vu-data's warranty.

1-12. PS900 BATTERY PACK

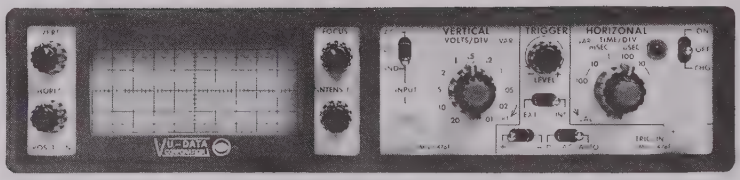
1-13. The battery pack uses eight ANSI type "C" cells connected in series and protected by a fuse accessible from the back panel. To change the batteries, remove the bezel and bottom cover by removing the 2 each #6-32 flathead screws from each side of the bezel and the 4 each #4-40 screws holding the bottom cover.

WARNING

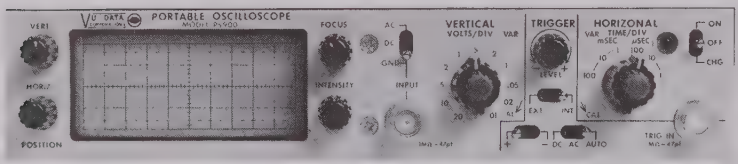
Before removing bottom cover, make sure the power switch is in the off position and the AC line cord is disconnected from the instrument back panel. This will avoid a possible lethal shock. If batteries are installed, it is a good precaution to remove the fuse in series with the batteries located on the back panel.

1-14. Next remove the snap in battery box cover and remove the individual cells. The cells are installed as indicated on the battery box cover and in Figure 1-3.

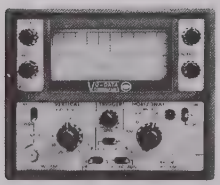
1-15. Snap in the battery box cover before reinstalling the instrument bottom cover and bezel.

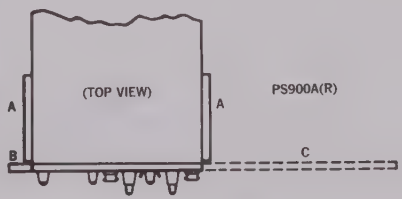


MODEL PS910A
For portable applications where a low profile chassis is convenient. Includes front panel bezel, protective hood and carrying handle/stand.



MODEL PS910A(R)
Ideal for panel or rack mounting where vertical panel space is restricted. A mounting kit is provided in lieu of the bezel, protective hood and handle/stand which are included with the PS910A. Battery case and recharging circuitry are included as well. Dimensions: 1¾" H x 8½" W x 12" D. See rack/panel mount kit diagram shown below.





MODEL PS920A

MODEL PS920A(R)

The PS920A (left) is identical to the PS910A, except that operating controls are positioned beneath the CRT. The PS920A(R) (right) is similarly related to the PS910A(R). These profiles are useful in applications where a narrow chassis width is desirable. Dimension: (PS920A(R): 3½"H x 4¼"W x 12"D.

The above diagram shows the rack/panel mount kit provided with the PS910A(R) and PS920A(R). Parts "A" (2 each) and "B" (1 each) are included. The "A" parts are used for panel mounting either unit through a 1/8 inch thick panel opening equal to the height and width dimensions listed above. Two 6-32 screws are used on either side to secure the "A" parts, and PS900A(R), to the panel. For rack mounting applications, "B" is used as a 1 inch ear for convenient mounting to the RETMA rail, while "C" is a customer supplied filler panel.

Figure 1-2. Various Configurations of Series PS900

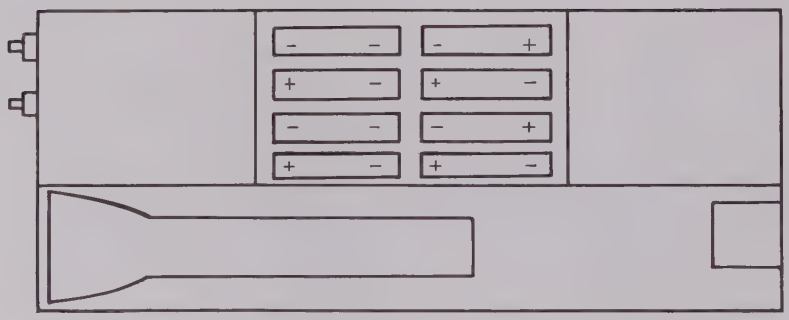


Figure 1-3. Battery Installation

1-16. In using the instruments on batteries, the battery protection fuse will blow when the battery pack voltag falls below about 8 volts. This prevents cell damage caused by too deep a discharge. A spare battery fuse is located within the instrument (accessible by removing the bottom cover). Once the fuse has blown the batteries should be recharged 12-14 hours (overnite) with the power switch in the "ch" position. The power on lite wi not come on in the "ch" position since the DC-DC converter is not operating during battery charging. If AC line power is available, the instrument need not be taken out of use just to charge the batteries after the batte fuse has blown. Replace the blown fuse and plug in the AC line cord before turning the power switch to oper ate. The internal battery charger will slowly recharge the batteries as the unit operates. An overnite charge is still recommended. In normal AC line usage, the battery charger keeps the battery pack in a trickle charged, ready to use condition. It is not necessary to have batteries installed for proper instrument operation if the instrument is connected to the AC power line.

1-17. Battery Types

The PS900 can use almost any type of sealed cylindrical "C" size primary or secondary batteries. A list of possible types to use is given in Table 1-1. For longest operation time and number of recharge cycles, the nickel-cadmium Gould Nicad SC-2 cell is recommended.

Battery Type	Class	Manufacturer	Part #	Approx. Oper. Time	Comment
1. Secondary	nickel-cadmium	Gould	SC2	5 Hr.	Highest Cost
2. Secondary	nickel-cadmium	Everyready	CH1.5	4.5 Hr.	Highest Cost
3. Secondary	nickel-cadmium	Burgess	CD-14	4.5 Hr.	Highest Cost
4. Secondary	nickel-cadmium	GE	GCT1.5SB	4.5 Hr.	Highest Cost
5. Secondary	alkaline	Mallory Duracell	SA14C	3-4 Hr.	Medium Cost
6. Secondary	alkaline	RCA	VS1514	3-4 Hr.	Medium Cost
7. Primary	alkaline	Everyready	E-93	4 Hr.	Medium Cost
8. Primary	alkaline	Mallory	MN-1400	4 Hr.	Medium Cost
9. Primary	alkaline	Burgess	AL-1	4 Hr.	Medium Cost
10. Primary	alkaline	RCA	VS1335	4 Hr.	Medium Cost
11. Primary	carbon zinc	any	— — —	Variable	Low Cost

Table 1-1. Battery Cell Data

1-18. Battery Recharging

It is possible to recharge a primary battery*, but only for a limited number of cycles and under controlled conditions. The PS900 does not allow the individual cells to discharge below 1.0 volt and the constant current charger supplies the recommended 12 to 14 hour recharge rate. Ordinary carbon-zinc flashlite batteries will give the shortest operating time and the least number of recharge cycles, while nickel-cadmium cells are the best available at a larger initial cost. Cell selection should be based upon the expected battery operation usage of the instrument. The batteries should be recharged very soon after discharge. Cell leakage is always a problem even though the cell may be labeled sealed or leakproof. Always remove the cells when they have expired to prevent damage to the instrument. If the instrument is not to be used for an extended period of time, removal of the cells is recommended. Also, never dispose of the cells in a fire as they may explode. To avoid cell venting and overpressure, do not charge at a cell temperature below $5^{o}C$.

*Letter Circular LC965-US Dept. of Commerce, National Bureau of Standards.

1-19. Battery Life

The operating time of the battery pack is quite a variable depending in part on the following factors:

a.) State of charge and charging temperature.
b.) Continuous or intermittent discharge operation.
c.) Memorization of depth of discharge.
d.) Sustained overcharge before discharge.
e.) Discharge temperature.
f.) Cell venting.
g.) Previous storage time for primary cells and rest time after charge for secondary cells.

1-20. In general, to optimize battery operating time, turn off the instrument when not in use.

1-21. Further Battery Information

Should the user require additional information about batteries, the following sources are suggested:

a.) General Electric Nickel-Cadmium battery Application Engineering Handbook.
b.) "Everyready" Battery Applications and Engineering Data (Union Carbide Co.).
c.) RCA Battery Manual, BDG-111B.
d.) RCA Alkaline Batteries, BAT-135A.

1-22. SPECIFICATIONS

VERTICAL DEFLECTION

BANDWIDTH: DC to greater than 20 MHz within 3 dB.
COUPLING: AC, DC or Ground, selectable. Low frequency limit with AC coupling is less than 2 Hz.
RISETIME: Less than 18 nsec.
DEFLECTION FACTOR: 10 mV/div in 11 calibrated ranges, 1-2-5 sequence; all ranges accurate to within 3% with vernier in Calibrate position. Vernier: Continuously variable between ranges; extends maximum deflection factor to approximately 50 V/div.
INPUT R AND C: 1 megohm within 2% paralleled by approximately 47 pF.
MAXIMUM INPUT VOLTAGE: 400V (DC + peak AC).

HORIZONTAL DEFLECTION

TIME BASE: 1 usec/div to 100 msec/div in 6 calibrated decade ranges; all ranges accurate to within 3% F.S. with vernier in Calibrate position. Vernier: Continuously variable between ranges (X1 to X10, uncalibrated); extends maximum sweep rate to 100 nsec/div.

TRIGGER

MODES: Automatic or manual level; "+" or "–" slope selection; internal or external. Automatic operation eliminates trigger level adjustments and is functional above 40 Hz.
COUPLING: AC and DC for both internal and external triggering; 200V maximum input voltage (DC + peak AC
AMPLITUDE REQUIREMENTS: 0.3 div deflection (internal) or 100 mV external to 1.5 MHz, increasing to 1 div deflection (internal) or 200 mV external at 20 MHz. Requirements increase below 40 Hz with internal or external AC coupling.
INPUT R AND C (EXTERNAL TRIGGER): 1 megohm within 2% paralleled by approximately 47 pF.

CRT

CRT: 4 x 10 div display area; each div is ¼ inch. CRT uses low-power filament, providing a useful display promptly after turn-on. P31 phosphor normally supplied.
GRATICULE: Black; vertical and horizontal centerlines marked in 5 minor divisions per major ¼ inch division. 10% and 90% risetime reference lines included.

ENVIRONMENTAL

AMBIENT TEMPERATURE: Operating: 0°C to +55°C. Non-operating: –55°C to +75°C without batteries; –40°C to +60°C with batteries. Charging: +5°C to +40°C.
ALTITUDE: Operating: 15,000 feet maximum. Non-operating 50,000 feet.
SHOCK AND VIBRATION: Will withstand the shock and vibration conditions encountered in normal commercial shipping and handling.
HUMIDITY: Will operate up to 95% relative humidity, non-condensing.

GENERAL

PROBE COMPENSATOR: 1V p-p square wave at external jack on rear panel. Useful for self-test.
PROBE: Standard oscilloscope probes can be employed. 3 ft. X1 alligator clip probe provided.
POWER SOURCES:

Internal DC source: Internal battery case contains provisions for 8 "C" size Nickel-Cadmium (Ni-Cad), Alkaline or Carbon-Zinc cells. Operating time using fully charged Ni-Cad batteries is approximately 4 to 5 hours, depending on signal frequency and amplitude, trace intensity and ambient temperature. Internal recharging circuitry provides for charging the internal batteries when connected to AC line in the Charge mode of operation. Battery circuit is fused on the rear panel so that operation is interrupted should battery voltage drop to a level at which Ni-Cad batteries would be damaged; spare fuse located beneath bottom cover.

External AC source: Operates from an external AC source of 105V to 125V, or 207V to 253V (selected by internal strap); 50 to 400 Hz; approximately 7 watts.

DIMENSIONS AND WEIGHTS:

	PS910	PS920
Height	1¾" (4.45 cm)	3½" (88.90 cm)
Width	8½" (21.50 cm)	4¼" (10.80 cm)
Depth	12" (30.48 cm)	12" (30.48 cm)
Weight	Approximately 5½ pounds (2.5 kg); add 1½ pounds (0.7 kg) for batteries; add 5 pounds (2.3 kg) for shipping.	

INCLUDED STANDARD ACCESSORIES: X1 alligator clip probe; detachable AC line cord; 1 each Option PS9004 Technical Manual-PS900; for PS910A and PS920A only: carrying handle/stand, bezel and front panel protective hood; for PS910A(R) and PS920A(R) only: rack/panel mount brackets.

OPTIONAL ACCESSORIES: Option PS9001 Ni-Cad Batteries (set of 8 each rechargeable "C" size cells). Option PS9002 Alkaline Batteries (set of 8 each rechargeable "C" size cells); Option PS9003 207V to 253V AC Line Operation; Option PS9004 Technical Manual-PS900 (1 each included at No Charge); Option PS9005 Rack/Panel Mount Brackets for PS910A (included as standard No Charge accessory for PS910A(R)); Option PS9006 Rack/Panel Mount Brackets for PS920A (included as standard No Charge accessory for PS920A(R)); Option PS9007 P-7 Phosphor.

1-23. ORDERING INFORMATION

MODEL PS910A Portable Oscilloscope ("Flat-Pack" with carrying handle/stand, bezel and front panel protective hood; batteries not included).

MODEL PS910A(R) Portable Oscilloscope ("Flat-Pack" with rack/panel mount brackets; batteries not included).

MODEL PS920A Portable Oscilloscope ("Stack-Pack" with carrying handle/stand, bezel and front panel protective hood; batteries not included).

MODEL PS920A(R) Portable Oscilloscope ("Stack-Pack" with rack/panel mount brackets; batteries not included).

OPTION PS9001 Ni-Cad Batteries (set of 8 each rechargeable "C" size cells).

OPTION PS9002 Alkaline Batteries (set of 8 each rechargeable "C" size cells).

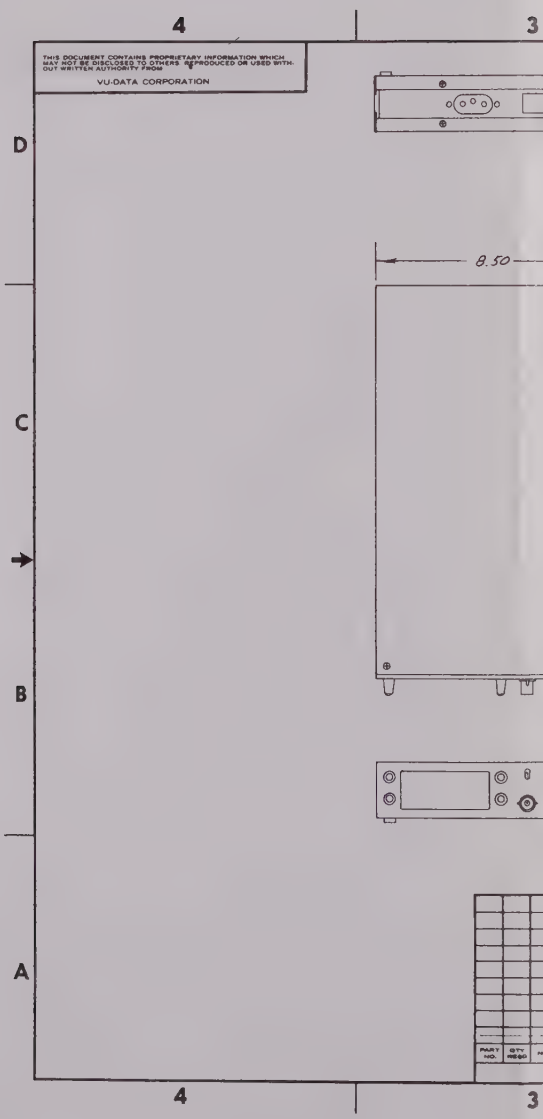
OPTION PS9003 207V to 253V AC Line Operation.

OPTION PS9004 Technical Manual-PS900 (one provided at No Charge with each PS900).

OPTION PS9005 Rack/Panel Mount Brackets for PS910A (included at No Charge with PS910A(R)).

OPTION PS9006 Rack/Panel Mount Brackets for PS920A (included at No Charge with PS920A(R)).

OPTION PS9007-7 P-7 Phosphor.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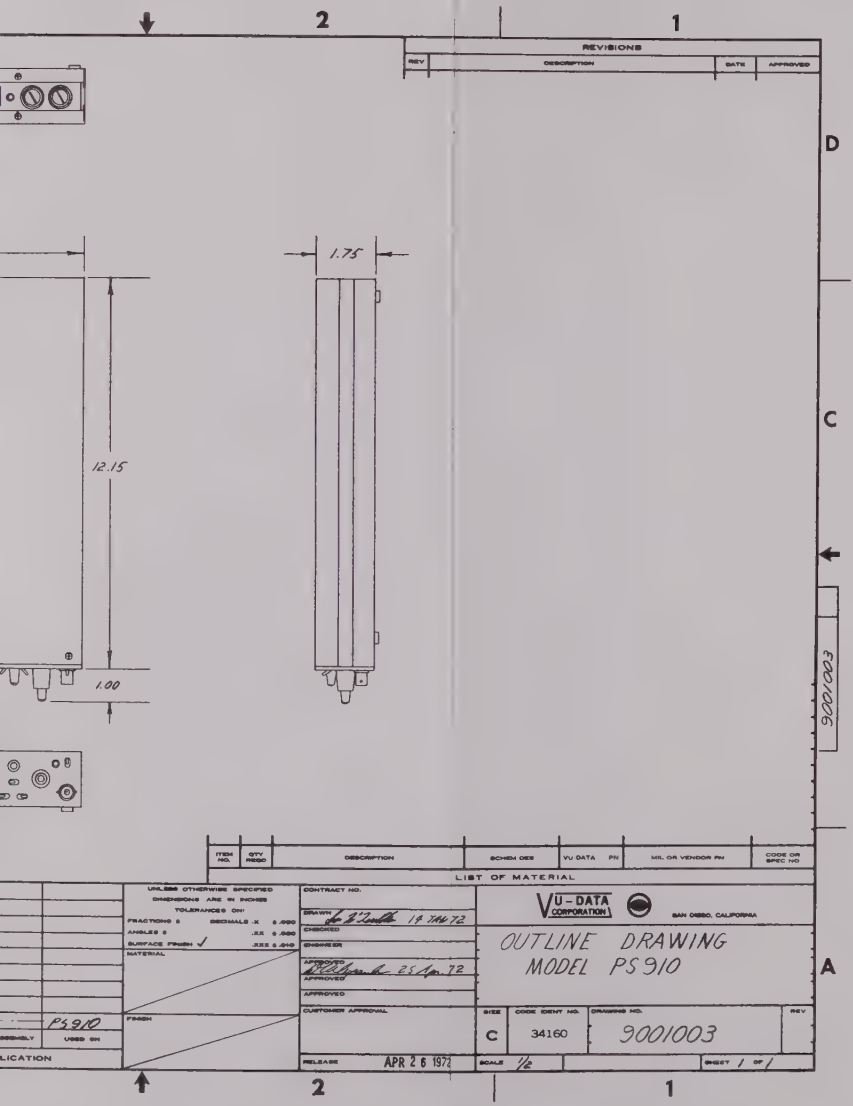
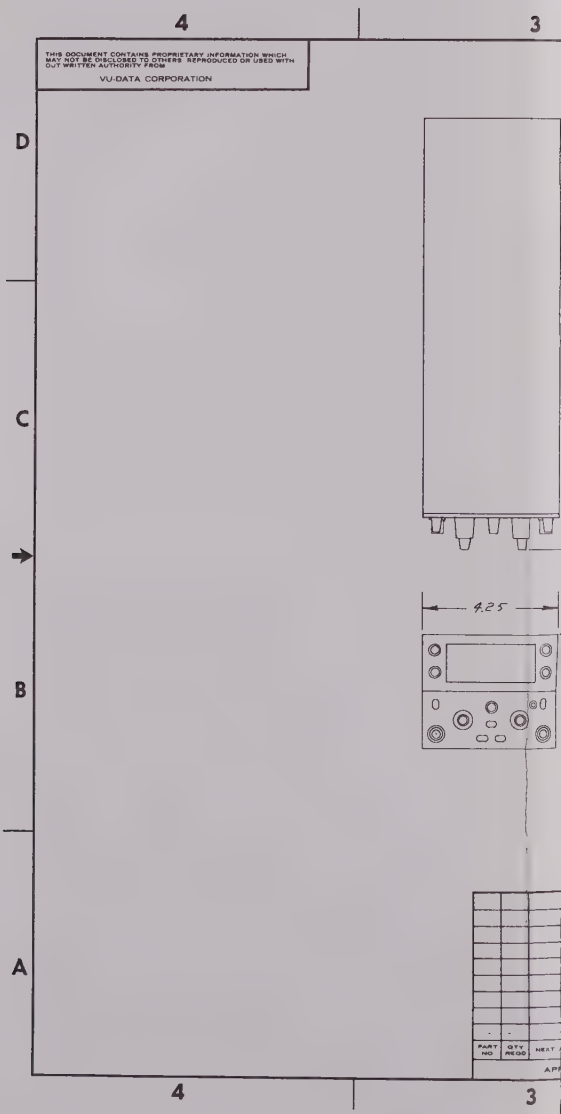


Figure 1-4. Dimension Drawing Model PS910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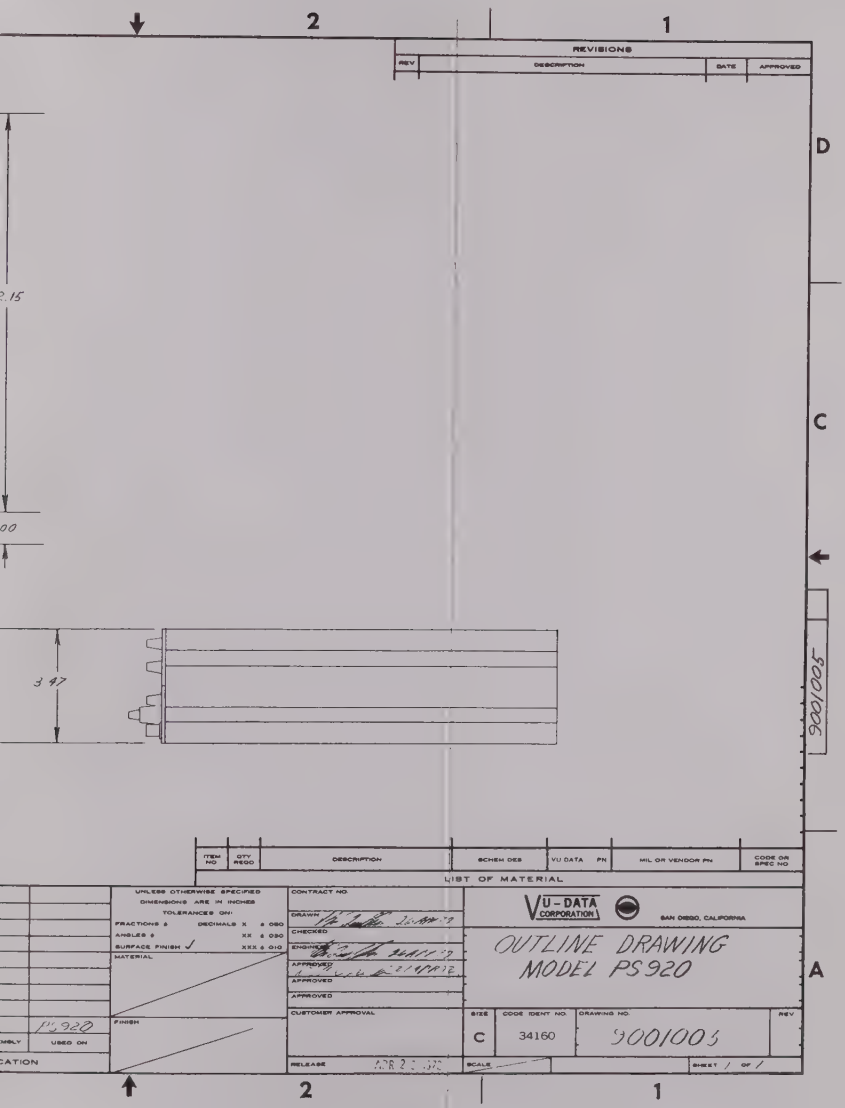
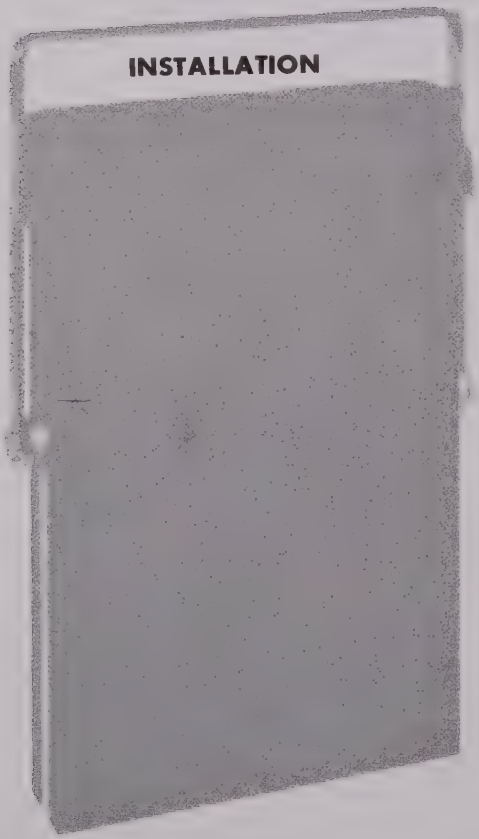


Figure 1-5. Dimension Drawing Model PS920

SECTION II



2-1. INSPECTION UPON RECEIPT

2-2. The Series PS900 is aligned, calibrated, and tested under severe environmental conditions prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure that the instrument has suffered no damage in shipment.

a. A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier. If extensive damage of the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be kept for inspection.

b. A visual inspection for damage should be accomplished upon removing the instrument from the shipping container. Remove the top and bottom cover and check for loose or broken components.

2-3. Battery Operation

The battery fuse is removed prior to shipment and must be installed prior to battery use.

NOTE

Protective circuits within the PS900 cause the fuse to blow when the batteries voltage falls below 8 volts. If the fuse is blown (F102) and the batteries are rechargeable, they should be charged for 12-14 hours with the power switch in the charge (ch) position prior to battery operation. The power lite does not come on in the charge position.

SECTION III

OPERATION

3-1. OPERATING CONTROLS

3-2. All of the controls necessary for the operation of the Series PS900 Mini-Portable Oscilloscope are located in such a way to facilitate the ease in operation required by the operator.

3-3. The Series PS900 consists of two-printed circuit boards, with connecting wires to the front panel operating controls. Figure 3-1 shows the location of these controls on the Model PS910. The controls are the same in the Model PS920. Table 3-1 describes the function and location of these operating controls.

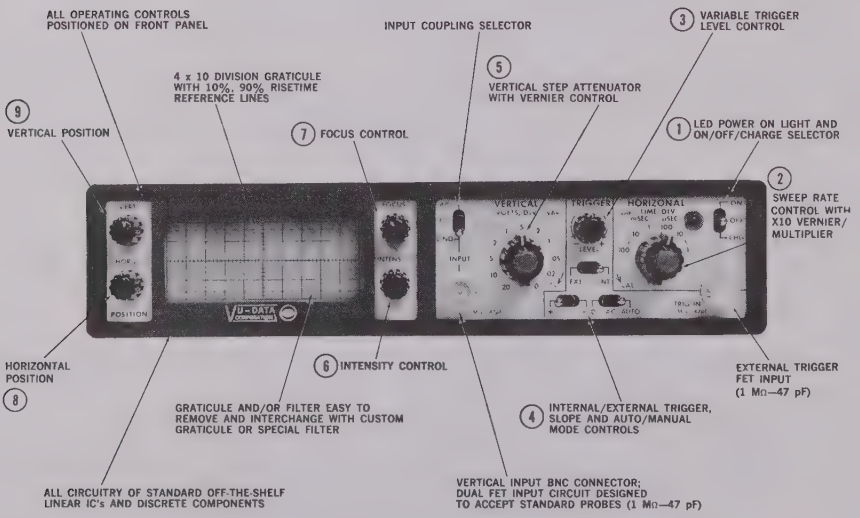

ALL OPERATING CONTROLS POSITIONED ON FRONT PANEL
INPUT COUPLING SELECTOR
3 VARIABLE TRIGGER LEVEL CONTROL
4 x 10 DIVISION GRATICULE WITH 10%, 90% RISETIME REFERENCE LINES
5 VERTICAL STEP ATTENUATOR WITH VERNIER CONTROL
9 VERTICAL POSITION
7 FOCUS CONTROL
1 LED POWER ON LIGHT AND ON/OFF/CHARGE SELECTOR
2 SWEEP RATE CONTROL WITH X10 VERNIER/ MULTIPLIER
HORIZONTAL POSITION
8
6 INTENSITY CONTROL
EXTERNAL TRIGGER FET INPUT (1 MΩ—47 pF)
GRATICULE AND/OR FILTER EASY TO REMOVE AND INTERCHANGE WITH CUSTOM GRATICULE OR SPECIAL FILTER
4 INTERNAL/EXTERNAL TRIGGER, SLOPE AND AUTO/MANUAL MODE CONTROLS
ALL CIRCUITRY OF STANDARD OFF-THE-SHELF LINEAR IC's AND DISCRETE COMPONENTS
VERTICAL INPUT BNC CONNECTOR; DUAL FET INPUT CIRCUIT DESIGNED TO ACCEPT STANDARD PROBES (1 MΩ—47 pF)
VERTICAL
TRIGGER
HORIZONAL
INPUT
LEVEL
POSITION
U-DATA

Figure 3-1. Model PS910 Operating Controls

CONTROL	POSITION	FUNCTION	NUMBER IN FIG. 3-1
POWER	ON	AC power applied when power cord connected to AC source or battery power applied when batteries installed and AC power cord removed	(1)
	OFF	AC or DC power removed from the instrument	
	CHG	With AC power cord connected to AC source, the batteries, Option 9001, are being charged. Power light is OFF during charge.	
HORIZONTAL TIME/DIV		Selects the Sweep Rate	(2)
	100 mSec	Measures frequency to 10 Hz.	
	10 msec	Measures frequency to 100 Hz.	
	1 msec	Measures frequency to 1 KHz.	
	100 usec	Measures frequency to 10 KHz.	
	10 usec	Measures frequency to 100 KHz.	
	1 usec	Measures frequency to 1 MHz.	
	X10 Vernier —	Continuous adjustment between each Freq. Range	
TRIGGER			
	Level	Selects the amplitude level on the triggering signal where sweep triggering occurs. This control does not function in AUTO.	(3)
	Int.	Signal trace will trigger on either the positive or negative portion of the input signal as determined by the polarity switch.	(4)
	Ext.	External position is for external triggering on a signal applied to the external trigger input connector.	(4)
SLOPE	+ or —	Signal will trigger on the (+) positive or (—) negative going portion of the signal	(4)
AUTO OR MANUAL TRIGGER	Auto	Trigger level is adjusted automatically	(4)
	AC	The AC position blocks the DC level of the triggering signal and allows triggering to occur only on the changing portion of the signal. With frequencies below 40 Hz, use the DC position.	
	DC	The DC position permits triggering on both high and low (to DC) frequencies.	

Table 3-1. Function and Location of Operating Controls

CONTROL	POSITION	FUNCTION	NUMBER IN FIG. 3-1
VERTICAL VOLTS/DIV	.01	Input signal to the vertical circuit is not attenuated	(5)
	.02	Attenuated to where .02V p-p equals 1 div	
	.05	Attenuated to where .05V p-p equals 1 div	
	.1	Attenuated to where .1V p-p equals 1 div	
	.2	Attenuated to where .2V p-p equals 1 div	
	.5	Attenuated to where .5V p-p equals 1 div	
	1	Attenuated to where 1.0V p-p equals 1 div	
	2	Attenuated to where 2.0V p-p equals 1 div	
	5	Attenuated to where 5.0V p-p equals 1 div	
	10	Attenuated to where 10.0V p-p equals 1 div	
	20	Attenuated to where 20.0 V p-p equals 1 div	
VERNIER		Uncalibrated vernier allows continuous adjustment between ranges.	
INPUT COUPLING	AC	Input signal is AC coupled to the vertical input	(6)
	DC	Input signal is DC coupled to the vertical input	
	GRD	The input signal is grounded	
INTENSITY	VAR	Controls brightness of the display	(6)
FOCUS	VAR	Used in conjunction with the INTENSITY control for obtaining a well-defined display	(7)
HORIZONTAL POS.	VAR	Positions the display along the horizontal axis of the CRT	(8)
VERTICAL POS.	VAR	Positions the display along the vertical axis of the CRT	(9)

Table 3-1. Function and Location of Operating Controls (Continued)

3-4. CONNECTORS AND FUSES

3-5. The connectors used in the Series PS900 are the input BNC, the external trigger BNC and the AC power connector, J103 shown in Figure 3-2. The input and trigger connectors, J101 and J102, are shown in Figure 3-1.

3-6. The Series PS900 uses 2 fuses. The locations are shown in Figure 3-2. Fuse F101 is the power fuse and is a ¼amp Slo-Blo. Fuse F102 is the battery protection fuse and is a 1 amp Fast-Blo. A spare fuse for F102 is located inside the unit.

NOTE

If battery voltage drops below 8 volts, fuse F102 will open. This prevents damage to the batteries.

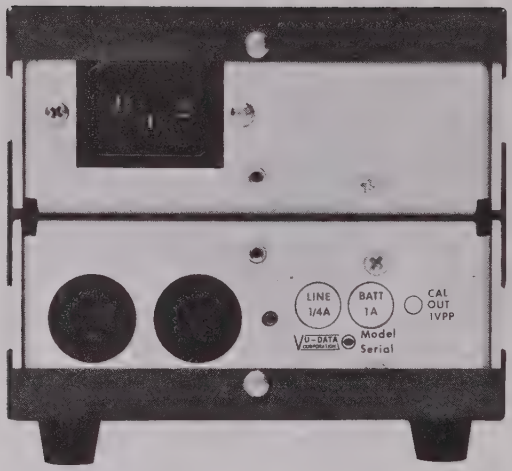


Figure 3-2. Rear View of Model PS920

3-7. ACCESSORIES

3-8. Battery Case

3-9. Each Series PS900 includes a battery case and cover as shown in Figure 3-3.

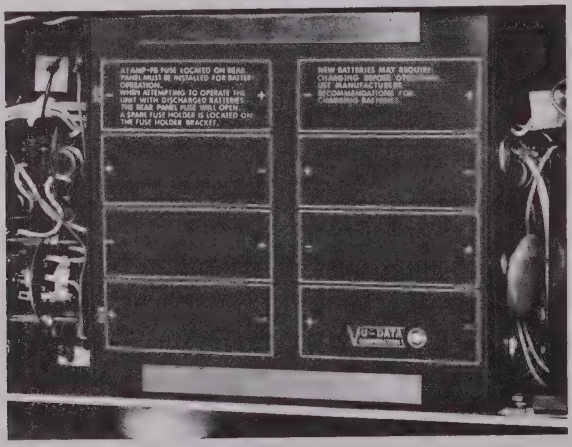


Figure 3-3. Battery Case and Cover

3-10. Protective Hood

3-11. A tough vinyl protective hood is furnished with bench versions of the Series PS900. This hood protects the front panel controls and CRT during transporting. Figure 3-4 shows a Model PS910A with its hood.

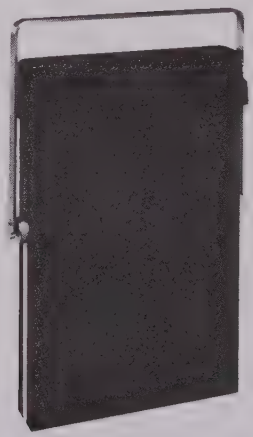


Figure 3-4. PS910 with Protective Hood and Handle

NOTE

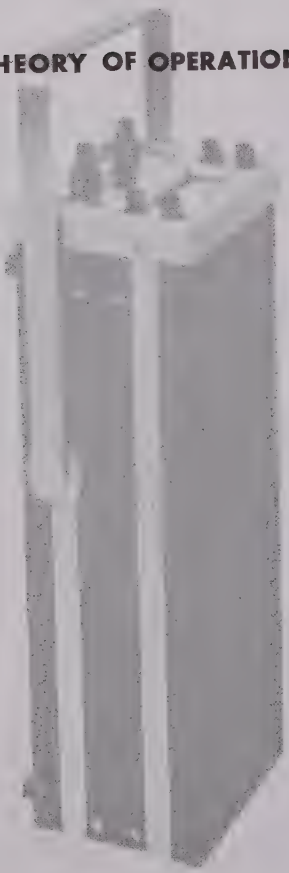
THE HANDLE USED ON THE 900 SERIES MINI-PORTABLE OSCILLOSCOPE IS A MULTI-POSITION POSITIVE LOCK. TO CHANGE POSITION, DEPRESS THE BUTTON ON THE LEFT SIDE AND MOVE THE HANDLE TO THE DESIRED POSITION.

3-12. Input Cable

3-13. A input cable is included in each Series PS900 Mini-Portable Oscilloscope.

SECTION IV

THEORY OF OPERATION



4-1. GENERAL

4-2. The PS900 Portable Oscilloscope is composed of the following basic circuits:

a.) Wideband, variable gain, vertical deflection amplifier.

b.) Controllable trigger generator circuit.

c.) Combination linear sweep generator and horizontal output amplifier.

d.) Blanking circuit.

e.) Power supply.

4-3. Refer to Figure 4-1 Block Diagram and Figure 7-1 schematic diagram to aid in understanding the theory of operation. 100 series reference designator parts are mounted off of the two printed circuit boards. 200 series designators are mounted on the Control and PS circuit board. 300 series designators are mounted on the Signal board.

4-4. VERTICAL DEFLECTION AMPLIFIER

4-5. The Vertical Deflection Amplifier is a wideband DC to 20 MHz, single ended input, differential output, amplifier having eleven stepped gain ranges with a two and one half to one gain decrease vernier control. Input signals are either AC or DC coupled into the amplifier's one megohm input impedance. The active circuitry consists of a dual FET buffer amplifier (U-201), a cascade bipolar buffer amplifier (U-202), an IC video amplifier (U-203), and a discrete component vertical output amplifier (Q-313, Q-314). U-201, U-202 and U-203 are located near the vertical attenuator switch (S-102 a, b, c) on the Control and Power Supply Board, while the vertical output amplifier is located on the Signal Board. Vertical positioning is provided by emitter followers Q315, Q316. The trigger take off emitter follower is Q319. Current sources Q17 and Q18 complete the active elements of the Vertical Deflection Circuit.

4-6. Detailed Description

4-7. Switch S-101 couples the vertical input signal from BNC connector J101 through C-101 for AC coupling, or direct for DC, to the vertical attenuator switch S-102. S-101 also has a position to ground the input to the vertical amplifier to aid in positioning the CRT trace.

4-8. The vertical attenuator switch, S-102, has three wafers. Wafers A and B switch the input signal either direct or a divide by 20 attenuator, or a divide by 400 attenuator. The C wafer changes the gain of video amplifier U-203. The gain relationships are shown in Table 4-1.

4-9. At low frequencies the vertical attenuator resistors provide the attention while the shunt capacitors become dominant at high frequencies. Attenuator peaking is controlled by C-104 and C-106. C-102 and C-103 maintain a constant input capacity so that an external divide by 10 probe may be used. R-241 supplies the one megohm input resistance. R-240 and C-232 provide the series impedance for overload protection diodes CR201 and CR202. Under an overload signal condition, the excess voltage is clamped by these diodes to the plus and minus power supplies, thus protecting the input FET transistor.

Switch Pos V/DIV	Input Atten.	U-203 Gain	Combined Gain
.01	X1	50	50
.02	X1	25	25
.05	X1	10	10
.1	÷20	100	5
.2	÷20	50	2.5
.5	÷20	20	1
1.0	÷20	10	0.5
2.0	÷400	100	0.25
5.0	÷400	40	0.1
10.0	÷400	20	0.05
20.0	÷400	10	0.025

Table 4-1. Vertical Attenuation - Gain Relationship

4-10. The input FET dual transistors, U-201, are connected as source followers which have a very high input impedance and low output impedance. Initial Vgs difference between the two transistors is adjusted out by R209. R107 is the vertical gain vernier which decreases the gain by a factor of 2.5 to 1. The high input impedance of U-202, twin Darlington connected emitter followers, allows linear operation of potentiometer R107. Adjustment R212 compensates for differences in Vbe of U-202 and the input stage of U-203. L201, C202 and L202, C204, C205 decouple the power supply lines.

4-11. Differential input and output IC video amplifier, U-203, has its gain controlled by resistors connected to terminals 4 and 9. An open between these pins sets the gain to≈10. Power supply decoupling is provided by R213, C-206 and R215, C207. The internal trigger is taken from pins 6 of U-203 and DC restored in diodes CR310 - CR314 so that the output voltage of emitter follower, Q319 is symetrical about ground. R228 calibrates the gain steps of U-203.

4-12. The discrete component output amplifier is composed of two common emitter amplifiers, Q313 and Q314, connected for differential input and output. Adjustment R352 changes the gain of the output amplifier to accomodate for differences in vertical deflection sensitivity between CRTs. R351 and C316 are factory selected values to optimize the very high frequency performance of the output amplifier. Emitter followers Q315 and Q316, controlled by the vertical position control, R114, cause the output amplifier to differentially trade current thus vertically positioning the CRT trace. Q317 and Q318 provide the collector loads for Q313 and Q314.

4-13. TRIGGER GENERATOR

The Trigger Generator is basically a squaring amplifier which converts analog input signals into fast risetime squarewaves for use in controlling the start of the horizontal sweep. In the automatic trigger mode of operation, the trigger generator operates as a 40 Hz free running multi-vibrator. This provides a trace on the CRT in the absence of an input signal. For input signals whose frequency is above the free running rate, the trigger generator is an IC voltage comparator, U-301, which has high gain and very fast response. With Q303 and Q304, it functions as a Schmidt Trigger and in Auto as a free running, triggerable multi-vibrator. FET source followers, Q201, Q202 provide a high 1 megohm input impedance for external signals to the Trigger Generator. Table 4-2 details the various controls and modes of operation of the Trigger Generator.

CONTROL	POSITION	FUNCTION
1. Trig Source Sw.	a) Int	Oscilloscope triggers from the vertical waveform.
	b) Ext	Oscilloscope triggers from an external signal supplied to the Trig Input BNC.
2. Trig. Mode Sw.	a) AUTO	Triggers are generated at approximately 40 Hz rate or synchronized to a higher frequency. Provides a trace in the absence of any input signal. Trig signals are AC coupled.
	b) AC	Signals are AC coupled to trig generator.
	c) DC	Signals are DC coupled to trig generator.
3. Trig Polarity Sw.	a) Plus +	Selects positive slope for sweep start.
	b) Minus –	Selects negative slope for sweep start.
4. Trigger Level Control	Variable Single Turn	Positions sweep start up and down waveform. This control is inoperative when AUTO mode is selected.

Table 4-2. Trigger Controls

4-14. Detailed Description

Switch S103 routes the input signal either from the EXT Trig input BNC connector, J-102, or from the internal trigger source, the emitter of Q319, to the trigger mode switch, S104 a, b. Section "a" of this switch controls the AC or DC coupling of the trigger input signal while section "b" changes the trigger generator U-301 into a 40 Hz free running multi-vibrator by switching in or out C110 and C111. One megohm input impedance is provided by R217. Clamp diodes CR205 and CR206 protect the input FET source follower transistor Q210 by shorting overload signals to the power supplies through the impedance of R206, R242 and C208, FET transistor Q202 provides a matching source voltage for Q201 and is matched at the factory for △ Vgs less than 0.1 volt at circuit ID. Potentiometer R113, the Trigger Level Control, varies the DC voltage at the gate of Q202 above and below zero volts. In the Auto Mode, Q301 acts as a switch shorting the gate of Q202 to ground. Q302 activates Q301 when operated by the Mode Switch. Polarity switch, S105 a, b, acts as a reversing switch in selecting the inputs to emitter followers, Q303 and Q304.

4-15. The trigger generator is an IC voltage comparator, U-301, which provides a digital output state dependent upon the polarity of its input terminals. R313 and R314 act as a voltage divider causing the comparator to act as a Schmidt trigger. R312 in conjunction with C110 and C111 when they are not shorted by the Mode Switch allow the comparator to oscillate at about 40 Hz. In this Auto mode input signals are still coupled through the capacitors to synchronize the comparator to the input trigger signal. Diodes CR301 and CR302 protect the comparator from overload signals. Power supply decoupling is provided by R315, C302 and R316 and C301. R317 and R318 establish the proper common voltage at pin 1 of the comparator. C304 decouples this pin 1 voltage to ground.

4-16. SWEEP GENERATOR AND HORIZONTAL OUTPUT AMPLIFIER

4-17. The Sweep Generator produces a linear zero to 20 volt ramp, which by means of the Horizontal Output Amplifier moves the CRT beam from the left side to the right. The Sweep Generator is controlled by the sweep control circuit. This circuit starts the ramp in synchronism with a trigger pulse, rejects other trigger pulses while the ramp is sweeping, resets the Sweep Generator to zero volts when the blanking monstable has fired and finally, controls the blanking flip flop to turn on and off the beam. An internal stability adjustment sets the operation of the sweep control circuit.

4-18. An IC operational amplifier U-302 is connected as an integrator to form the linear Sweep Generator. FET switch, Q309, resets the integrating capacitor to zero volts after every sweep. The blanking monostable assures that the integrating capacitor has been completely discharged before allowing the trigger generator to initiate the next sweep. The sweep Generator has six fixed decade ranges and one variable ten to one range. This provides a sweep range from 0.1 seconds per division to≈ 100 nanoseconds per division.

4-19. The Horizontal Output Amplifier is a discrete component differential input and output amplifier with sufficient gain to amplify the output of the Sweep Generator to drive the horizontal deflection plates of the CRT. One input to the amplifier is driven by the Sweep Generator and the other by the horizontal position control.

4-20. Detailed Description

4-21. Sweep Generator

4-22. IC operational amplifier U302 integrates the constant current derived from the network R116, R118, R117, R119 as selected by the Time Per Div switch S106c. The proper integration capacitor is selected by S106b. C-311 is matched to C-312 to plus or minus 1% and the combination of C-313 and C-314 is ratioed to the matched capacitor set by means of the adjustable capacitor C-314. A ten to one increase in integrating current is provided by R120 suppling a voltage from ground to minus 7.8V. CR307 and CR308 protect the input to the integrator from overloads. C307 is the Op-amp feed forward compensation capacitor to increase the slew rate. FET Q309 discharges the integrating capacitor after every sweep. The end of the sweep is determined by the blanking monostable, Q310, Q311, whose firing point is adjusted by sweep length adjustment R329. The monstable time is determined by capacitor C-321 for the one and 10 microsecond per div. ranges, by C-230 for the 100 microsecond and 1 millisec ranges, and by C-231 for the 10 and 100 millisecond ranges.

4-23. The sweep control circuit, Q305, Q306, Q307, Q308 is actuated by differentiated trigger pulses from U301 through C303 and voltage levels which activate diode CR304 from the collector of inverter Q312. Q307 and Q308 form a complementary NPN/PNP emitter follower whose input signal drives the FET reset switch and whose output supplies the blanking flip flop control pulse. The stability control R320 is adjusted for a triggered sweep and may cause the sweep to free run if maladjusted.

4-24. HORIZONTAL OUTPUT AMPLIFIER

The Horizontal Output Amplifier is composed of Q321, Q322, Q323, Q324 and Q325. Emitter follower Q320 provides impedance buffering for the Horizontal Position Control R115. Q325 is a constant current drain for differential amplifier transistors Q322 and Q324. Q321 and Q324 buffer the amplifier feedback summing modes. The gain is adjusted by R374 to compensate for variations in CRT horizontal deflection sensitivity. High frequency compensation is provided by L301, L302, C318 and C320.

4-25. BLANKING CIRCUIT

To turn off the CRT trace, the blanking grid must be driven more negative than the cathode voltage. The intensity of the trace depends on how close the blanking grid returns to the cathode voltage. A complementary NPN/PNP four transistor flip flop is used to drive the blanking grid with very fast rise and fall times. The intensity is controlled by varying the supply voltage to this flip flop. Since the Blanking Circuit is located at about minus 2000 volts, the flip flop is triggered by pulses coupled via a 390 pico farad 3KV capacitor from the sweep control circuit.

4-26. The blanking flip flop is composed of Q327, Q328, Q329, and Q330. At the end of the sweep, the sweep control circuit puts out a plus change in voltage level which turns on Q330 through capacitor C323. This pulse also turns off Q327 through C322. Q330 turning on causes current to flow through R384 and the base emitter junction of Q329. This turns on Q329 but the degree of saturation is controlled by R380, CR316, R377 and R378 for faster switching times. The blanking grid is thus connected to the – 2045 volt supply cutting off the CRT. A negative input pulse causes the flip flop to switch to the opposite state. However, the turn on voltage is controlled by the DC voltage output of Q326 as adjusted by the front panel intensity control R121. Protection diodes CR305 and CR306 keep high voltage transients from affecting the sweep circuits. Zener diode CR317 and C324 raises the CRT cathode voltage toward ground so that the blanking flip flop does not have to swing more than 45 volts.

4-27. POWER SUPPLY

Power is drawn either from the AC power line or from the internal battery pack when the power switch is switched to on (the up position) depending upon the AC line voltage. Whenever the AC line falls below about 105V rms, the batteries supply the current to operate the oscilloscope. Should the battery pack voltage drop below 8V, the minus 7.8 volt regulator stops regulating which then fires the SCR crowbar circuit. The SCR places a low resistance across the batteries blowing the fuse in series with the batteries. This prevents the battery pack from becoming deeply discharged with consequent damage to the individual cells. When the AC line voltage is within normal limits, the batteries are trickle charged so that they will always be ready for use. Placing the power switch to the "ch" position allows the battery pack to be completely charged overnite (about 12-14 hours).

4-28. The power supply consists of a step down AC line transformer, bridge rectifiers and filter capacitor, a battery charger constant current regulator, battery pack, crowbar, –7.8V DC regulator and a DC to DC converter supplying the other DC and filament voltages.

4-29. Unregulated DC Supply

AC line voltage is conducted through the line fuse and power switch to the primary of T101. The secondary voltage of T101 is rectified by CR207 and filtered by C210 to a nominal 17 volts DC.

4-30. Battery Charger Constant Current Regulator

Q101 (mounted on the side rail) operates as a constant current DC supply having two current rates; one rate for operating the oscilloscope, and a second lower rate for charging the battery pack. The two rates are switched by S107b, the front panel power switch, which selects either the parallel combination of R225 and R226, or R227. The upper voltage limit of the constant current supply is controlled by CR208, CR209, CR210 and CR211. This voltage limit prevents overcharging the battery pack by tapering off the charge as the battery pack voltage rises.

4-31. Minus 7.8 Volt Regulator

Zener diode, CR222, provides a −5.6 volt reference for one input to IC operational amplifier, U204. The other input comes from R235 which adjusts the output voltage of the regulator. The output of U204 is coupled through CR220, CR221 and R231 to the base of Q203. Q203 drives the regulator series pass transistor Q102, which is mounted on the other side rail. Should U204 fall out of regulation, its output voltage rises toward ground causing the crowbar, CR215, to fire shorting the battery fuse. Capacitor C213 prevents the SCR from firing during initial turn on.

4-32. DC to DC Converter

Toridal transformer, T102, and transistors Q204 and Q205 form a square wave power oscillator operating at about 5 KHz. The plus 6.8 V supply is rectified and filtered from the primary of the transformer. The Cal output Voltage is obtained by clipping the square wave primary voltage in CR225 and CR226. CR227 and C229 rectify and filter the +180V supply. CR228 and C228 rectify and filter the +30V supply. CR229 and C221 rectify and filter the floating −45 volt supply which is connected to the −2000 volt supply making a −2045 volt supply. Rectifiers CR226 through CR229 and capacitors C222 through C227 are connected as a voltage quadrupler to supply −2000V. The 1.5 volt O-P filament voltage is not rectified but supplied to the CRT as a 5 KHz square wave. When the power oscillator is operating, current through LED101 causes the power on light to glow red.

NOTE

When the instrument is triggered externally from signals larger than approximately 6 volts, internal overload protection is provided. An external trigger attenuator is recommended however, to avoid any possible trigger signal coupling into the vertical deflection circuit whenever large external trigger signals are used.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High voltages, which could be lethal are accessible and extreme caution should be taken.

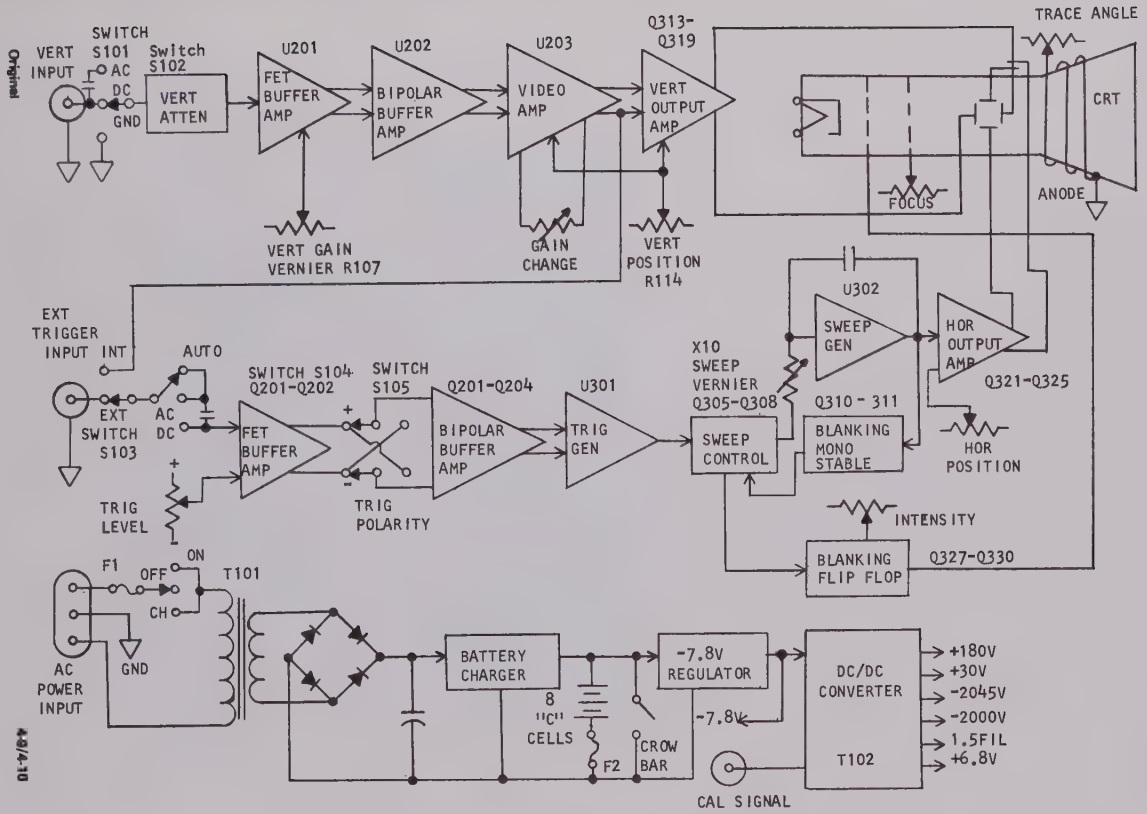
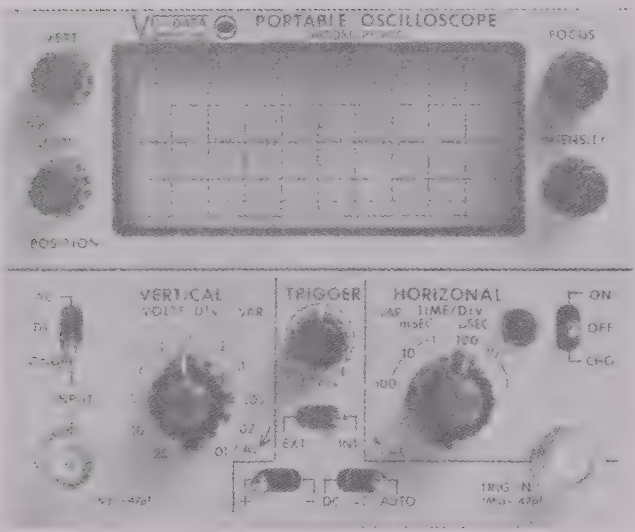


Figure 4-1. Block Diagram, Series PS900

SECTION V

MAINTENANCE



5-1. GENERAL

5-2. The following procedure provides the information necessary for technical personnel to align and calibrate the Series PS900 Mini-Portable Oscilloscope. The alignment should be accomplished at regular periodic intervals to ensure the proper operation of the instrument.

5-3. The Series PS900 consists of two models, these are: (1) Model PS910 and (2) Model PS920. The alignment and calibration of these models is covered in this procedure. The calibration of the Power Supply portion should always be done prior to the Signal portion.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High voltages, which could be lethal are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The top cover should be removed only for the duration of time required to make the alignments. The power should be off while the cover is being removed or installed.

5-4. Test Equipment Required

5-5. The following test equipment is required to align and calibrate the instrument. The model number and manufacture may be substituted if the specifications of the substituted units are equal to or better than the listed equipment.

1. Sine Wave Generator	HP Model 651B
2. Square Wave Generator	HP Model 211B
3. Frequency Counter	HP Model 5321B
4. RMS Voltmeter	HP Model 3400A
5. DC Voltmeter	Honeywell Model 500
6. Pulse Generator	SD Model 101
7. Constant Amplitude Generator	Tek Model 191

5-6. LOCATION OF CONTROLS FOR ALIGNMENT

5-7. Figure 5-1 shows the location of the front panel controls. Figure 5-2 shows the location of the controls on the Control and Power Supply assembly and Figure 5-3 shows the location of the controls in the Signal assembly.

5-8. Power Supply Calibration

5-9. To measure the power supply voltages in the Series PS900 it is necessary to remove the top and bottom covers. ALWAYS REMOVE POWER PRIOR TO REMOVAL OF COVERS. When batteries are utilized, the Power Switch (1), as shown in Figure 5-1 must be in the OFF position.

5-10. Minus 7.80 VDC Supply

5-11. With a DVM, monitor the −7.8 VDC supply. Adjust R235 for a regulated output voltage of −7.80 VDC ± 10 mv.
5-12. Other VDC Supplies
5-13. With a DVM, confirm the other Supply Voltages are:

1) +6.8 VDC ± 0.1 VDC
2) +30 VDC ± 1.0 VDC
3) +45 VDC ± 1.0 VDC
4) +180 VDC ± 2.5 VDC

5-14. There are no controls for these voltages as they are controlled by the −7.8 VDC. If an error is present, recheck the −7.8 VDC and then recheck.

DO NOT ATTEMPT TO MEASURE THE −2000 and the −2045 VDC circuit without a DVM or Divider Input.

5-15. PRE-ADJUSTMENTS

NOTE

5-16. After a 10 minute warmup has been given, preset the controls as shown in Table 501. Location of these controls are shown in Figure 5-1.

Vertical Position	Mid-Range
Horizontal Position	Mid-Range
Trigger Polarity	+
Focus	Mid-Range
Intensity	CW
Input Mode	GRD
Trigger Level	Mid-Range
AC/DC/AUTO	Auto
Ext/Int	Int
V. Volt/Div.	.1
V. Vernier	Cal
H Time/Div	1 msec
X10 Vernier	Cal
Power Switch	ON

Table 5-1. Control Pre-Adjustments

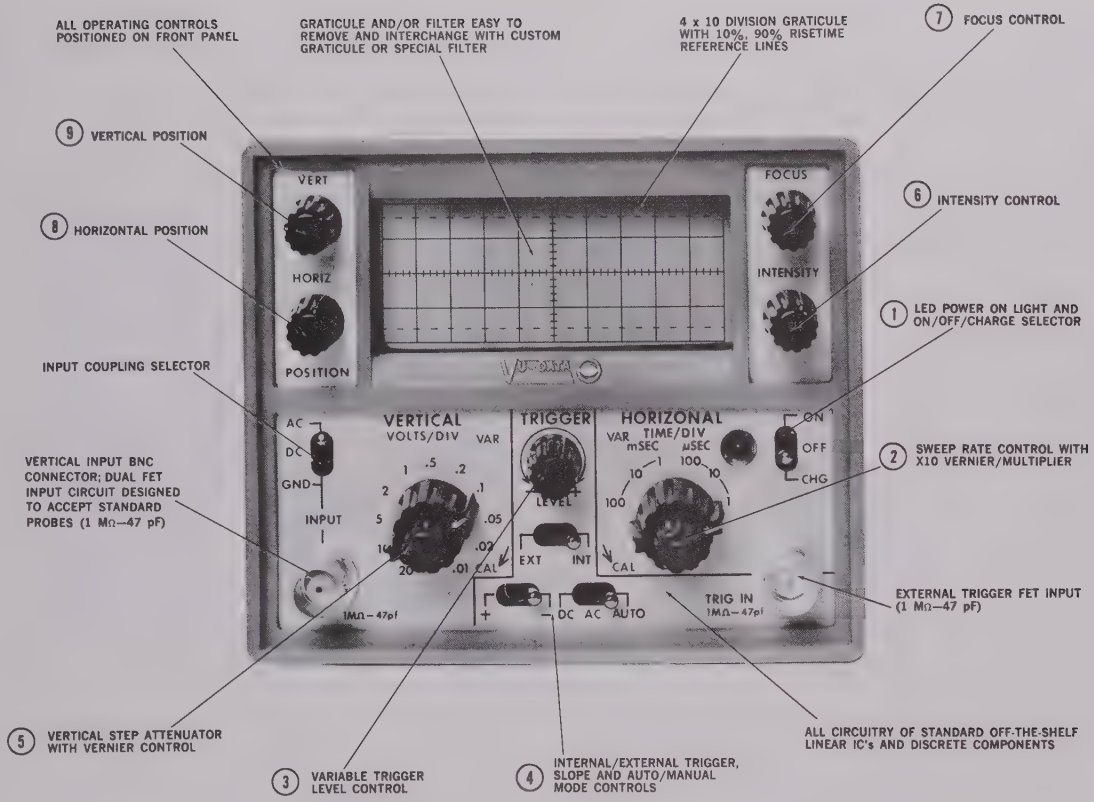


Figure 5-1. Model PS920 Front Panel Controls

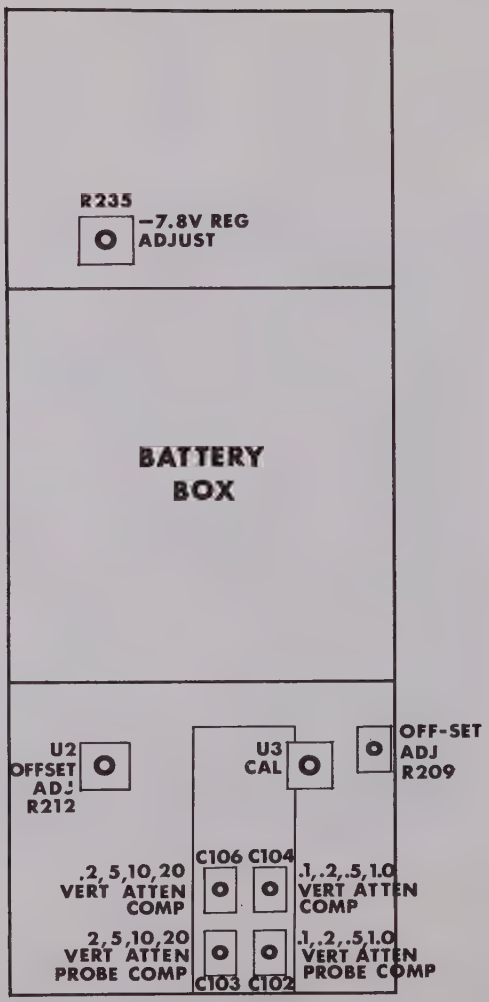


Figure 5-2. Control Locations on Control and Power Supply Assembly

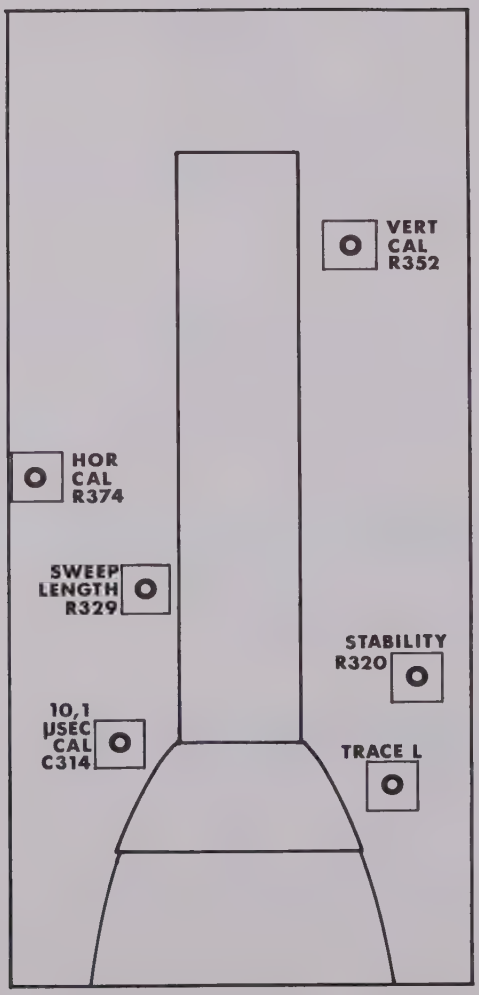


Figure 5-3. Control Locations on Signal Assembly

5-17. Control Pre-Adjustments

5-18. Adjust the vertical and horizontal position controls for a centered sweep. Adjust the focus and intensity controls for a desired display.

NOTE

A constant trace with maximum intensity may burn the phosphor on the cathode ray tube (CRT). THE WARRANTY ON THE CRT DOES NOT COVER PHOSPHOR BURNS.

5-19. Using the sine wave generator, with a load of 50 ohms, (1) apply a 0.4 V p-p sine wave @ 1 KHz to the input BNC connector.

5-20. A stable 1 KHz sine wave should be displayed on the CRT. If the signal does not trigger properly, adjust the stability control potentiometer R320 for a stable display at a point midway between where the display disappears and where the display free runs or becomes unstable.

NOTE

A CW rotation will cause the display to disappear and a CCW rotation will cause the display to become unstable.

5-21. Trigger Polarity

5-22. With the trigger polarity switch, (4), located on the front panel, as shown in Figure 5-1, in the + position, the start of the display should occur during the positive slope of the cycle. Switch the polarity to – and the start of the display should occur during the negative slope of the cycle.

5-23. To verify the variable trigger level control (3), position the Auto/AC/DC Mode control switch (4) to AC and rotate the trigger level potentiometer for a steady trace.

5-24. External Trigger

To verify the operation of the external trigger, place the Ext/Int switch (4) as shown in Figure 5-1 to the EXT position and apply an input from the sine wave generator to the external trigger input. Adjust the sine wave generator for an output of 100 mv p-p. The display should continue to be a stable display of 1 KHz.

5-25. VERTICAL ACCURACY

5-26. With the power switch in the OFF position, connect the Constant Amplitude Signal Generator to the vertical input, using a 50 ohm load. Position the controls as follows:

1)	Vert Atten	50 mv/div
2)	Trig. Switch	Int
3)	Trig Mode Switch	Auto
4)	Trig Pol	+

Using an ohmmeter, measure between pins 4 and 9 of IC, U203 and adjust resistor R228 until ohmmeter reads 1000 ohms ±5 ohms.

5-27. Set the output of the signal generator to 200 mv p-p @ 50 KHz and turn on the power switch. The vertical signal should be 4 major division of deflection. The Vertical Calibration pot R352, as shown in Figure 5-3 may be adjusted if required. Be sure the Vertical Vernier Control is in the Cal (calibrate) position. Rotate the Vertical vernier control from one end to the other and check for any DC level shift. If the level shifts, adjust R209, located on the Control and PS assembly as shown in Figure 5-2 for minimum DC shift.

5-28. Zero Shift

5-29. Set the Vert Input Coupling Switch to the GRD position and switch alternately between the 1 V/Div and 2V/Div Vertical Attenuator positions and if needed adjust resistor R212 in the control and PS assembly for minimum shift. Refer to Figure 5-2.

5-30. Attenuator Compensation

5-31. Connect a square wave oscillator to the input and adjust the oscillator for 100 mv output @ 1 KHz. Set the Vertical Attenuator switch for 50 mv/div and observe the square wave signal on the CRT. Adjust the Horizontal Switch for a display of approximately 2 cycles. The square wave should be free from abnormal rounding or peaking. Figure 5-4 shows the square wave output signal in an over, under and properly compensated waveform. Switch the Vertical Attenuator switch to the 0.1 Volt/Div position and increase the oscillator output for a suitable display. Capacitors C104 may be adjusted to square the signal. Switch the Vertical Attenuator switch to the 2 Volt/Div position and increase the oscillator output for a suitable display. Adjust capacitor C106 if required.

5-32. Connect a divide by 10 input probe to the input and set the Vertical Attenuator switch to the 50 mv/div position. Using a square wave source at 1 KHz, adjust the probe for the best square wave. Switch the Vertical Attenuator to the 0.1 V/div position and adjust capacitor C102 for the same waveform previously obtained changing the oscillator amplitude as required. Switch the Vertical Attenuator to the 2 V/dv position and adjust capacitor C103 for the best square wave.

5-33. HORIZONTAL ACCURACY

NOTE

To remove the Front Panel Control knobs, remove the button from the front portion by using a small flat blade screwdriver which exposes a screw. Loosen the screw and remove knob.

5-34. Position the front panel controls as follows:

1)	Horz. Vernier	CAL
2)	Horz. Time/Div	1 mSec/Div
3)	Trig. Switch	Int.
4)	Trigger Mode	AUTO

Connect an oscillator to the input and set the frequency to 1 KHz ±1%. Adjust the Vertical Attenuator switch for a suitable display.

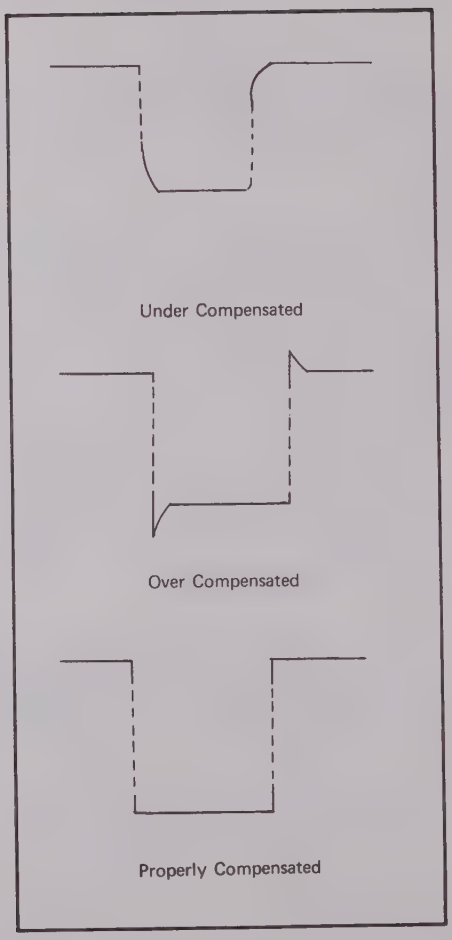


Figure 5-4. Attenuator Compensation

5-35. Sweep Length

5-36. The length of the sweep should be 12 divisions. To determine the length, adjust the horizontal position control for the sweep to start on the 1st vertical line of the graticule. Rotate the horizontal position control CCW until the peak of the last sine wave has moved 2 divisions. The end of the sweep should now be located approximately on the last vertical line of the graticule. Potentiometer R329, on the signal board as shown in Figure 5-3 may be adjusted if required.

5-37. Horizontal Calibration

5-38. The display on the CRT should be 1 cycle for each division on the graticule. For ease in observation, the signal should be positioned so the peaks of each cycle are on the center horizontal line of the graticule, (vertical position) and the peak of each cycle on a vertical division line (horizontal position). The peaks must align within the division graduation with ±3% of full scale (0.3 division). Potentiometer R374 may be adjusted if required.

5-39. Switch the oscillator to 100 Hz ±1% and the Hor. Time/Div Switch to 10 msec. Check the calibration on this range and if necessary, split the difference between the two ranges by readjusting the Hor Cal Control, R374.

5-40. Switch the oscillator to 100 KHz ±1% and the Hor Time/Div Switch to 10 usec per div. Adjust C-314 for 1 cycle/div.

5-41. Switch the oscillator to 1 MHz ±1% and the Hor Time/Div Switch to 1 usec per Div. Check for 1 cycle per div and if necessary, split the difference between the two ranges by readjusting C-314.

5-42. This completes the alignment of the Series PS900 Mini-Portable oscilloscope. Figure 5-3 includes the trace angle adjustment which positions the horizontal trace on the horizontal axis.

5-43. Figure 5-5 and 5-6 are used to show the parts locations and their reference designators on the various assemblies.

NOTE

When replacing components on a printed circuit board, care should be taken to prevent damage to the board from excessive heat or solder bridges. Obvious damage caused by improper techniques will negate the warranty. Soldering irons used should be less than 40 watts.

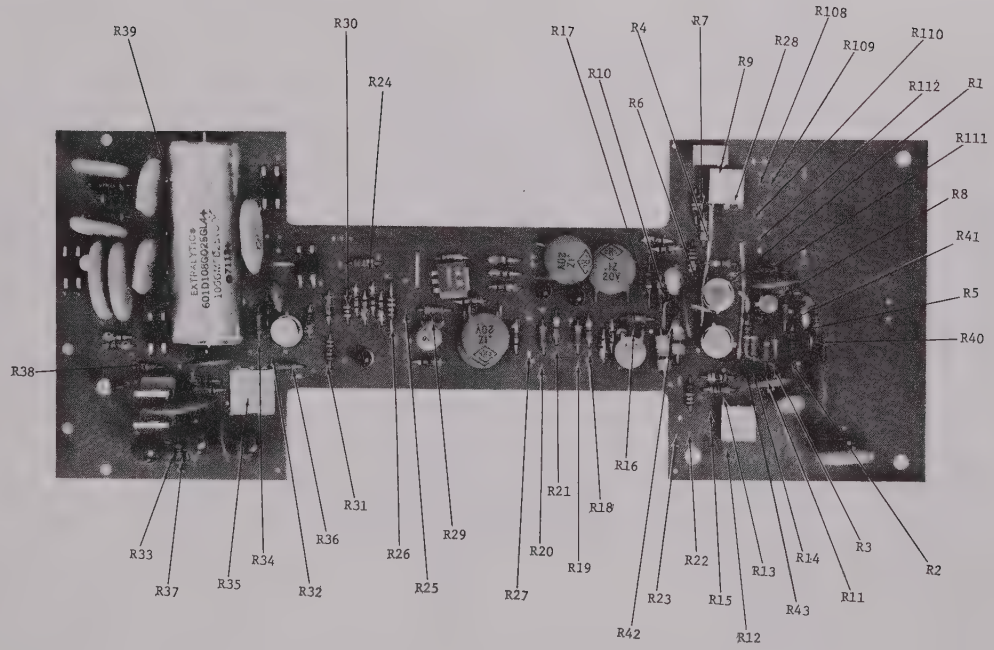


Figure 5-5. Parts Location for Control and Power Supply Assembly (Resistors Only)

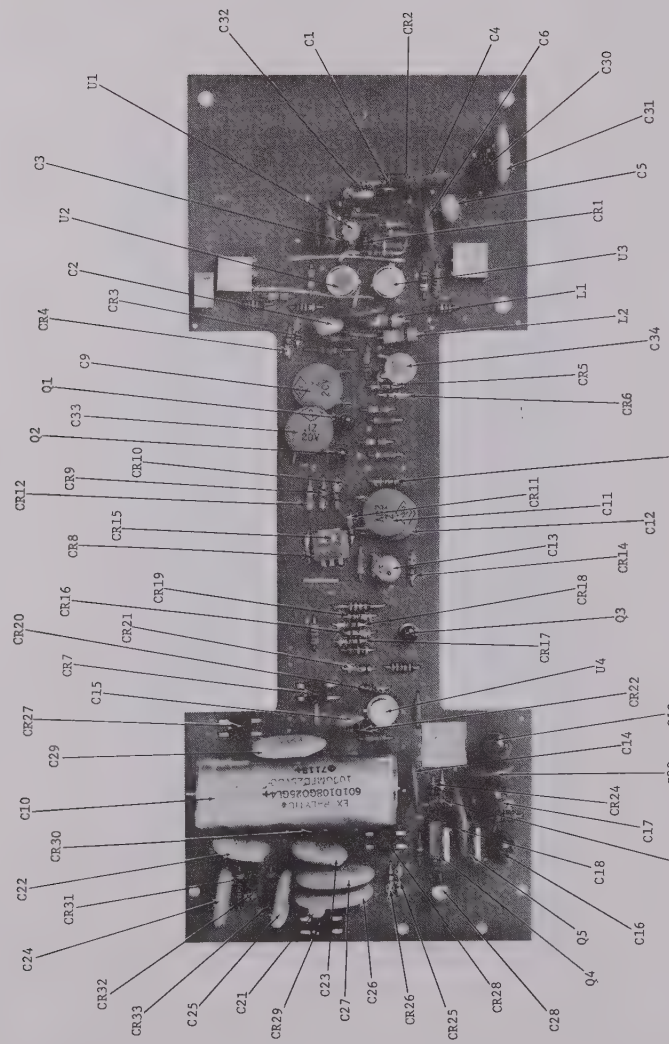


Figure 5-6. Parts Location For Control and Power Supply Assembly (Components Except Resistors) See Figure 5-5 for Resistors)

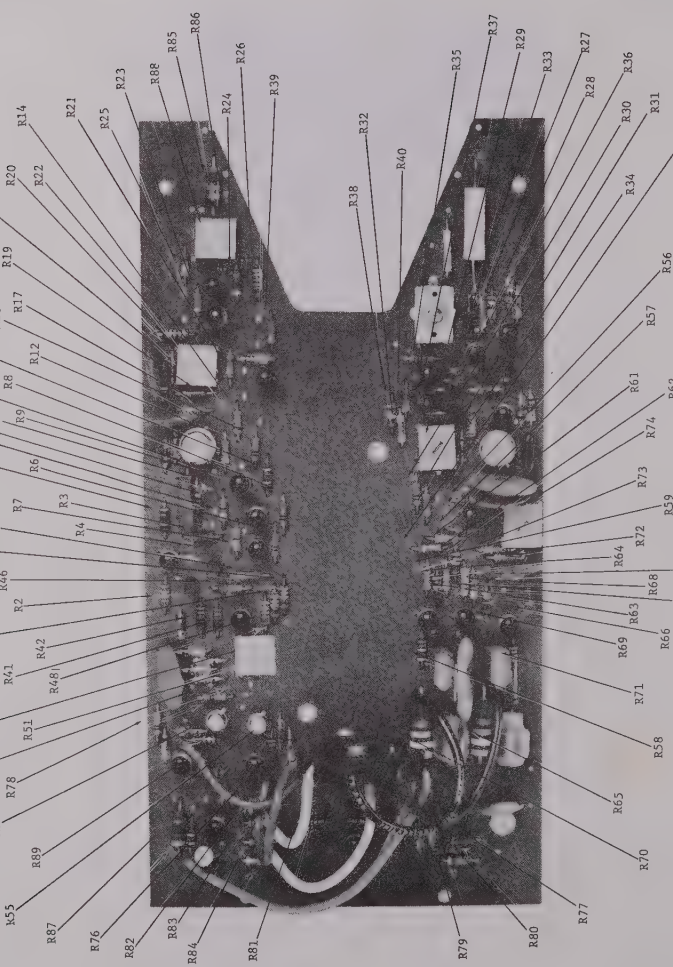


Figure 5-7. Parts Location Signal Assembly (Resistors Only)

Figure 5-8. Parts Location Signal Assembly (Components Except Resistors) See Figure 5-7 for Resistors

SECTION VI

PARTS LISTS

Mfg. Code Number	Manufacturer	Location
00853	Sangamo	Marion, Illinois
01121	Allen Bradley	Milwaukee, Wisconsin
01294	Texas Instruments	Dallas, Texas
04062	Elmenco	New York, New York
04713	Motorola	Phoenix, Arizona
05397	Kemet	Cleveland, Ohio
07263	Fairchild	Mt. View, California
12406	Elpac	Fullerton, California
14099	Semtech Corp.	Newbury Park, California
14752	Electrocube	S. Pasadena, California
15818	Amelco	Mt. View, California
24931	Specialty Connector Co., Inc.	Indianapolis, Indiana
26533	Zero	Burbank, California
27556	IBM	Santa Fe Springs, California
28520	Heyman Mfg., Co. (Heyco)	Kenilworth, New Jersey
34160	Vu-data Corp.	San Diego, California
44655	Ohmite Mfg., Co.	Skokie, Illinois
56289	Sprague	North Adams, Massachusetts
71450	CTS	Elkhart, Indiana
71590	Centralab	Milwaukee, Wisconsin
76055	Mallory	Frankfort, Indiana
78488	Stackpole	St. Mary's, Pennsylvania
78553	Tinnerman Products	Cleveland, Ohio
80368	Sylvania	New York, New York
81073	Grayhill	La Grange, Illinois
83330	H. H. Smith	Brooklyn, New York
84171	Arco	Great Neck, New York
86684	RCA	Harrison, New Jersey
87034	Marco-Oak	Anaheim, California
88245	Useco	Van Nuys, California
90201	Mallory	Indianapolis, Indiana
91637	Dale	Columbus, Nebraska
91662	Elco	Willow Grove, Pennsylvania
92219	Waldom	Chicago, Illinois
94222	Southco	Chester, Pennsylvania
95566	Arnold Eng.	Orange, California
99800	Delevan Electric Corp.	Aurora, New York

Table 6-1. Manufacturer's Codes

Table 6-2. PS910 Assemblies

ASSEMBLY NUMBER	SUB-ASSEMBLY
9005001	Control Board
9005002	Signal Board
9005003	Front Panel
9005004	Portable Oscilloscope
9005005	Vertical Switch
9005006	Horizontal Switch
9005007	Position Control
9005008	High Voltage Control
9005009	Battery Box

Additional Parts for PS910 Only		VU-DATA PART NO.
9002043	Cover Front	1-10290
9002044	Bezel	1-10299
9002065	Handle	1-10298
Additional Parts for PS910AR only		
9002066	Support Panel	1-10295
9002067	Panel Rack	1-10296

Table 6-3. PS920 Assemblies

ASSEMBLY NUMBER	SUB-ASSEMBLY
9005001	Control Board
9005002	Signal Board
9005005	Vertical Switch
9005006	Horizontal Switch
9005007	Position Control
9005009	Battery Box
9005010	Front Panel CRT
9005011	Front Panel
9005012	Final Assembly
9005013	High Voltage Control

Additional Parts for PS920 only		VU-DATA PART NO.
9002008	Cover Front	1-10310
9002057	Bezel	1-10300
9002068	Handle	1-10309
Additional Parts for PS920AR only		
9002073	Support Panel	1-10313
9002074	Panel Rack	1-10314

Table 6-4. Parts List (Control and Power Supply Board)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
——	9003001	Printed Wiring Bd.	1-10034	34160
U1	FD1673	I.C. Amp, FET	3-21673	Solitron
U4	LM301A	I.C. Amp LM301A	3-30301	National
U3	USF7733393	I.C. Amp 733	3-30733	07263
U2	CA3036	I.C. Amp CA3036	3-33036	86684
C1	DM15CD180K03	Cap DM 18pf, 500V, 5%	6-19180	04062
C3,4,6,7,9,11 12,34,20,33	UK20-104	Cap CD 1uf, 20V, +80% −20%	6-24104	71590
C2,5,13	T360C686M015AS	Cap Tant 68uf, 15V ±20%	6-73686	05397
C10	601D108G025GL4	Cap Elect 1000 uf, 25V	6-84102	56289
C8,15,34	DDM-103	Cap CD .01uf,150V,+60% -40%	6-27103	71590
C16,17,19	T360D227M010AS	Cap Tant 220uf, 10V ±20%	6-76227	05397
C21,28	T360B475M050AS	Cap Tant 4.7uf, 50V ±20%	6-76475	05397
C29	5GA-P10	Cap CD .1uf, 500V, ±20%	6-29103	56289
C22-25	3888Z5U .045uf 1KV ±20%	Cap CD .045uf, 1KV,±20%	6-29045	Erie
C26,27	30GAS10	Cap CD .01uf, 3KV, ±20%	6-29104	56289
C18	UK25-154	Cap CD .15uf, 25V, ±20%	6-27153	71590
C30	DM15FD511J03	Cap DM 510pf, 500V, ±5%	6-19511	04062
C31	TG-S50	Cap CD .05uf, 100V, ±20%	6-29050	56289
CR27	MDA920-5	Diode Bridge	3-19205	04713
CR3-6,9-14, 16-21,23-26	1N914	Diode Signal	3-10914	QPL
CR8	1N963B	Diode Zener	3-10963	04713
CR22	1N5232A	Diode Zener	3-15232	04713
CR30-33	SCM40	Diode Rectifier	3-10350	14099
CR15	MCR106-1	Diode SCR	3-10106	04713
CR28-29	MDA920-1	Diode Bridge	3-19202	04713
CR7	MDA920-1	Diode Bridge	3-19201	04713
R9	3299W-1-103	Res.Var.Cermet 10Kohm	5-72103	Bourns
R35	72XWR10K	Res.Var.Cermet 10Kohm	5-73103	Beckman
R12	72XWR1K	Res.Var.Cermet 1Kohm	5-73102	Beckman
R2	RC07GF162J	Res.CC 1.6Kohm ¼W 5%	5-10162	01121
R25,27	RC07GF	Res.CC TBD ¼W 5%		01121
R13	RC07GF390J	Res.CC 39 ohm ¼W 5%	5-10390	01121
R15	RC07GF101J	Res.CC 100 ohm ¼W 5%	5-10101	01121
R1,4,18,21	RC07GF181J	Res.CC 180 ohm ¼W 5%	5-10181	01121
R31,37	RC07GF331J	Res.CC 330 ohm ¼W 5%	5-10331	01121
R24	RC07GF271J	Res.CC 270 ohm ¼W 5%	5-10271	01121
R32	RC07GF122J	Res.CC 1.2 Kohm ¼W 5%	5-10122	01121
R33	RC07GF102J	Res.CC 1Kohm ¼W 5%	5-10102	01121

Table 6-4. Parts List (Control and Power Supply Board) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
R3,5,19,20, 39	RC07GF472J	Res.CC 4.7Kohm ¼W 5%	5-10472	01121
R30	RC07GF153J	Res.CC 15Kohm ¼W 5%	5-10153	01121
R11,14	RC07GF822J	Res.CC 8.2Kohm ¼W 5%	5-10822	01121
R6	RC07GF273J	Res.CC 27Kohm ¼W 5%	5-10273	01121
R10,29	RC07GF333J	Res.Car 33Kohm ¼W 5%	5-10333	01121
R22	RC07GF154J	Res.Car 150Kohm ¼W 5%	5-10154	01121
R8,16,38, 42,43	RC07GF104J	Res.Car 100Kohm ¼W 5%	5-10104	01121
R17,41	RN60D1005F	Res MF 1Mohm ¼W 5%	5-10105	91637
R36	RN55D3481F	Res MF 3.48Kohm 1/8W 1%	5-51245	91637
R34	RN550D1652F	Res MF 16.5Kohm 1/8W 1%	5-51320	91637
R26	RC20GF3R3J	Res Car 3.3 ohm ½W 5%	5-20033	01121
R23	RC07GF184J	Res Car 180Kohm ¼W 5%	5-10184	01121
R7	RC076GF224J	Res Car 220Kohm ¼W 5%	5-10224	01121
R40	RN55D1003F	Res Car 100Kohm 1/8W 1%	5-81003	91637
R28	72XWR50K	Res Var.Cer 50K	5-73503	Beckman
Q4,5	D44-C3	Tran. NPN Pwr.	3-144C3	GE
Q1,2	KE4093(matched)	Tran. NCH FET	3-21837	Solitron
Q3	2N3694	Tran. NPN SIG	3-23694	07263
L1,2	R1537-52	Choke RF 33 uhy	5-90033	99800
CR1,2	FD300	Diode G.P.	3-10300	07163
C32	1055-T47	Cap.CD 470 pf, 1KV,±10%	6-27471	56289
——	207-120241-03-0101	Button Nylon	NPN	Fastex

Table 6-5. Parts List (Signal Board)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
--	9003002	Printed Wiring Bd.	1-20035	34160
U1	U5B771039X	I.C. Comp 710	3-30710	07263
U2	LM318	I.C. Amp LM318	3-30301	National
C3	DM15CD050K03	Cap DM 5pf,500V,±5%	6-19050	04062
C21,13	DM15ED820J03	Cap DM 82pf,500V,±5%	6-19820	04062
C9,10	DM15ED680J03	Cap DM 68pf,500V,±5%	6-19680	04062
C23	DD30391J	Cap CD 390pf, 3KV,±20%	6-29391	71590
C22	DDM-103	Cap CD .01uf,150V,+60 -40%	6-28103	71590
C1,2,4,17, 25	UK-20-104	Cap CD .1uf,20V,+80%,-20%	6-24104	71590
C11,12	9002070	Cap (matched set) 1uf, .01uf	6-56003	34160
C19	5GA-P10	Cap CD .1uf, 500V ±20%	6-29103	56289
C6,15	UK50-104	Cap CD .1uf, 50V, ±20%	6-26104	71590
C24	T360B475M050AS	Cap Tant Dip 4.7uf,50V,±20%	6-76475	05397
C8,16,18,20		Cap Select. During Test		
C5,27	DM15ED330J03	Cap DM 33pf,500V,±5%	6-19330	04062
C14	PC-402	Cap Var Mica 1.5-20 pf	6-96001	04062
CR1-16,18-21 18-21	1N914	Diode G.P.	3-10914	07263
CR17	1N969A	Diode Zener	3-10969	04713
R42	72XWR10K	Res.Var.Cer 10K	5-73103	Beckman
R29	72XWR25K	Res.Var.Cer 25K	5-73253	Beckman
R88	72XWR50K	Res.Var.Cer 50K	5-73503	Beckman
R74	72XWR100K	Res.Var.Cer 100K	5-73104	Beckman
R20	72XWR1K	Res.Var.Cer 1K		Beckman
R19	RN55D3321F	Res.MF 3.32Kohm 1/8W 1%	5-83321	91637
R13	RC07GF330J	Res.CC 330 ohm ¼W 5%	5-10331	01121
R15,16	RC07GF100J	Res.CC 10 ohm ¼W 5%	5-10011	01121
R22,26,34	RC07GF681J	Res.CC 680 ohm ¼W 5%	5-10681	01121
R24	RC07GF471J	Res.CC 470 ohm ¼W 5%	5-10471	01121
R1	RC07GF680J	Res.CC 68 ohm ¼W 5%	5-10680	01121
R27	RC07GF820J	Res.CC 82 ohm ¼W 5%	5-10820	01121
R7,11	RC07GF181J	Res.CC 180 ohm ¼W 5%	5-10181	01121
R83	RC07GF221J	Res.CC 220 ohm ¼W 5%	5-10221	01121
R51,43,66,9	RC07GF	Res. Select. On Test	5-1	01121
R41,42,50, 55	RC07GF151J	Res.CC 150 ohm ¼W 5%	5-10151	01121
R37	RC07GF822J	Res. 8.2Kohm ¼W 5%	5-10822	01121
R23	RC07GF182J	Res.CC 1.8Kohm ¼W 5%	5-10182	01121
R18	RC07GF242J	Res.CC 2.4Kohm ¼W 5%	5-10242	01121
R25	RC07GF272J	Res.CC 2.7Kohm ¼W 5%	5-10272	01121

Table 6-5. Parts List (Signal Board) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
R17	RC07GF392J	Res.CC 3.9Kohm ¼W 5%	5-10392	01121
R31,77,82	RC07GF472J	Res.CC 4.7Kohm ¼W 5%	5-10472	01121
R39	RC07GF222J	Res.CC 2.2Kohm ¼W 5%	5-10222	01121
R35,45,57	RC07GF102J	Res.CC 1Kohm ¼W 5%	5-10102	01121
R6,8,20,30, 80,81,76, 56	RC07GF103J	Res.CC 10Kohm ¼W 5%	5-10103	01121
R4,62,64, 69	RC07GF153J	Res.CC 15Kohm ¼W 5%	5-10153	01121
R14	RC07GF203J	Res.CC 20Kohm ¼W 5%	5-10203	01121
R2,48	RC07GF223J	Res.CC 22Kohm ¼W 5%	5-10223	01121
R78,89	RC07GF202J	Res.CC 2Kohm ¼W 5%	5-10202	01121
R3,12,59, 61,63,72, 75	RC07GF333J	Res.CC 33Kohm ¼W 5%	5-10333	01121
R36	RC07GF393J	Res.CC 39Kohm ¼W 5%	5-10393	01121
R40,46,47	RC07GF332J	Res.CC 3.3Kohm ¼W 5%	5-10332	01121
R5,38,49, 28	RC07GF104J	Res.CC 100Kohm ¼W 5%	5-10104	01121
R85,86	RC20GF126J	Res.CC 12M ½W 5%	5-20126	01121
R32	RN55D3922F	Res M.F. 39.2Kohm 1/8W 1%	5-51356	91637
R79,84	RC07GF473J	Res.CC 47K ¼W 5%	5-10473	01121
R33	RN55D4752F	Res.MF 47.5Kohm 1/8W 1%	5-51364	91637
R67	RN55D8451F	Res.MF 8.45Kohm 1/8W 1%	5-88452	91637
R68	RN55D3920F	Res.MF 392 Ohm 1/8W 1%	5-83920	91637
R21	RN55D1821F	Res.MF 1.82Kohm 1/8W 1%	5-18121	91637
R60,73	RC07GF183J	Res.Car 18Kohm ¼W 5%	5-10183	01121
R58,71	RC07GF824J	Res.Car 820Kohm ¼W 5%	5-10824	01121
R87	RC20GF825J	Res.Car 8.2M ½W 5%	5-20825	01121
R65,70	RCR32GF393J	Res.Car 39Kohm 1W 5%	5-30393	01121
--	207-120241-03 0101	Button Nylon	F.S.	Fastex
Q8,15,16,27 29	GET2907	Tran. PNP SIG	3-22907	GE
Q2-7,8,20,21 24-26,28,30 ~~27,29~~	2N3694	Tran. NPN SIG	3-23694	07263
Q9	KE4093	Tran. NCH FET	3-21837	Solitron
Q22,23	D40-N2	Tran. NPN Power	3-240N2	GE
Q1,10,11	2N4250	Tran. PNP SIG	3-24250	07263
Q13,14	TP290	Tran. NPN SIG	3-22369	TPI
Q12	2N4275	Tran. NPN SIG	3-24275	07263
L1,2	70F102A1	Choke 10 mhy	5-90005	99800
--	35C4348P32	Socket, CRT	2-5000	91662

Table 6-6. Parts List (Front Panel Sub-Assembly PS910)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
--	9002033	Panel - Front	1-10283	34160
--	9002034	Panel - Controls	1-10284	34160
--	9002015	Bracket - CRT	1-10275	34160
--	9005006	Switch - Horiz. Sub-Assy.		34160
--	9005005	Switch -- Vert Sub-Assy.		34160
--	9003008	Graticule	2-60001	34160
--	9002055	Protector - Face Plate	4-20039	34160
--	9002049	Spacer - Filter	1-10287	34160
R113	MLD 54L	Res.Var 50K Carbon	5-78503	Mallory
S103	7101	Switch-Toggle SPDT	2-10003	C & K
S1-7	7203	Switch-Toggle DPDT	2-10016	C & K
S101,104	7211	Switch-Toggle DPDT	2-10002	C & K
S105	7201	Switch-Toggle DPDT	2-10015	C & K
J101,102	31-221-1015	Connector-BNC Pnl UG1094/U	2-28998	Amphenol
LED101	MV5023	Power Indicator LED RED	3-15023	Monsanto
--	021-123	Knob - Red	4-10009	Elma
--	021-222	Knob - Black	4-10011	Elma
--	023-352	Knob - Black	4-10013	Elma
--	040-103	Cap - Red	4-10010	Elma
--	040-103	Cap - Black	4-10012	
--	C17370-012-4	Clip 4-40	4-20013	78553
--	MS35649-44	Nut - 4-40	F.S.	
--	MS35333-36	Washer, Int. Lock 4-40	F.S.	
--	8322	Spacer-250 x 375 Lg.4-40 Tap	4-20046	83330
--	1497	Solder Lug 3/8 ID	F.S.	83330
C101	625B1E104K	Cap, Mylar .1uf,400V,±10%	6-59104	14752
C110,111	T360B106M020AS	Cap,Tant 10uf,20V,±20%	6-71106	05397
C109	5GA-P10	Cap CD .1uf,500V,±20%	6-29103	56289

Table 6-7. Parts List (Portable Oscilloscope Assembly PS910)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
——	9005001	Cont.Bd. Sub-Assy.		34160
——	9005002	Signal Bd. Sub-Assy.		34160
——	9005003	Front Panel Sub-Assy.		34160
——	9005007	Pos. Control Sub-Assy.		34160
——	9005008	High Volt. Cont. Sub-Assy.		34160
——	9002004	Panel-Right Side	1-10272	34160
——	9002011	Panel-Left Side	1-10274	34160
——	9002007	Divider-Center	1-10286	34160
——	9002016	Shield-Transformer	1-10269	34160
——	9002019	Support-P.C. Board	1-10276	34160
——	9002010	Bracket-Fuse Holder	1-10288	34160
——	9002002	Cover-Top	1-10271	34160
——	9002001	Cover-Bottom	1-10270	34160
——	9002022	Panel-Rear	1-10277	34160
——	9002028	Shield-Switch	1-10278	34160
——	9002009	Spacer	1-10273	34160
——	9002051	Cover-Battery	1-20036	34160
——	9002052	Angle-Cover	1-10293	34160
——	9002046	Transformer DC-DC Conv.	7-61005	34160
——	9002045	Coil Trace Angle	5-90003	34160
——	2122001	CRT Shield	1-10100	34160
——	9005009	Battery Box Assy.		34160
——	9003007	Label ID	4-20042	34160
——	3BGP31	CRT	3-40001	80368
——	LAC3GD	Conn Recpt Line	2-23997	Switchcraft
——	9002047	Transformer	7-61006	34160
——	2342	Spacer 1/4 x 3/8L 4-40 THD	4-20043	83330
——	HMM	Fuse Holder	2-40007	Buss
——	3AG1A	Fuse 1A	2-40009	Buss
——	3AG 25ASb	Fuse ¼A Sb	2-40004	Buss
——	D44-C3	Tran. NPN Pwr.	3-244C3	GE
——	F4B	Feet, Cabinet	4-30037	Budwig
——	G3-1000-101	Test Jack-White	2-50009	83330
——	021-222	Knobs - Black	4-10011	Elma
——	040-103	Knob Caps - Black	4-10012	Elma
——		Clip Anode	F.S.	
——	DF-103C	Mica Insulator		86684
——	DF-137A	Washer-Insulating		86684

Table 6-7. Parts List (Portable Oscilloscope Assembly PS910) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
—	MS24693-2	Screw 100° 4-40 x ¼		
—	MS51957-15	Screw Pan 4-40 x 3/8		
—	MS51957-19	Screw Pan 4-40 x 3/4		
—	MS51957-20	Screw Pan 4-40 x 7/8		
—	MS51957-17	Screw Pan 4-40 x ½		
—	MS35333-36	Washer Int Lk 4-40		
—	MS35649-44	Nut 4-40		
—		Fender Washer 1 3/8 OD x 1/4 ID x 1/16		Handyman
—	4521-22-30-1C	Clip Fuse	2-40010	Sea Strom
—	7A125V-1	Power Cord	2-70004	Beldon

Table 6-8. Parts List (Switch-Vertical Sub-Assembly)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
--	9002025	Switch-VERTICAL	2-10018	87034
C108	DM15ED470J03	Cap.DM 47pf,500V,±5%		04062
C102,103	PC402	Cap.Var.5.5-18 pf Mica	6-96001	04062
C104,106	PC400	Cap.Var.2-8 pf Mica	6-96000	04062
C105	DM15ED680J03	Cap.DM 68pf,500V,±5%	6-19680	04062
C107	DM15FD511J03	Cap.DM 510 pf,500V,±5%	6-19511	04062
R103	RN60D1005F	Res.MF 1Mohm 1/8W 1%	5-51490	91637
R110	RN55D78R7F	Res.MF 78.7 ohm 1/8W 1%	5-87870	91637
R108	RN55D2210F	Res.MF 221 ohm 1/8W 1%	5-82210	91637
R112	RN55D3010F	Res.MF 301 ohm 1/8W 1%	5-83010	91637
R109	RN55D634oF	Res.MF 634 ohm 1/8W 1%	5-86340	91637
R111	RN55D1001F	Res.MF 1Kohm 1/8W 1%	5-81001	91637
R104	RN55D2551F	Res.MF 2.55Kohm 1/8W 1%	5-82551	91637
R102	RN55D5232F	Res.MF 52.3Kohm 1/8W 1%	5-85232	91637
R101	RN60D9533F	Res.MF 953Kohm 1/8W 1%	5-50488	91637
R107	MLC252L	Res. Var. 2.5K Carbon	5-77252	76055
R105	RC07GF331J	Res.CC 330 ohm ¼W 5%		01121

Table 6-9. Parts List (Switch-Horizontal Sub-Assembly)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
——	9002024	Switch-HORIZONTAL	2-10017	
R116	RN55D4222F	Res.MF 42.2Kohm 1/8W 1%	5-51264	91637
R117	RN55D4221F	Res.MF 4.22Kohm 1/8W 1%	5-51262	91637
R118	RN60D3833F	Res.MF 383Kohm 1/8W 1%	5-51438	91637
R119	RN55D3832F	Res.MF 38.3Kohm 1/8W 1%	5-51355	91637
R120	MLC2536	Res.Var. 25Kohm Carbon	5-77253	76055

Table 6-10. Parts List (Position Control Sub-Assembly)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9002032	Bracket, Resistor, L.H.	1-10282	34160
	MLC54L	Res. Var. 50K Car.	5-77503	76055
	MLC252L	Res. Var. 2.5K Car.	577252	76055
	180	Coupler Shaft 1/8"	F.S.	83330
	9002069	Shaft Extension	F.S.	34160

Table 6-11. Parts List (High Voltage Controls Sub-Assembly)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9002031	Bracket-Resistor R.H.	1-10281	34160
	MLCN5M	Resistor-Var. 5.0M	5-78505	76055
	MLCN54L	Resistor-Var 50K Carb.	5-77503	76055
	2664	Shoulder Washer	F.S.	83330
	2675	Washer Nylon	F.S.	83330
	180	Coupler - Shaft 1/8"	4-20003	83330
	9002069	Shaft Extension	F.S.	34160

Table 6-12. Parts List (Battery Box Assembly)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9002041	Case "C" Cells	1-10289	34160
	9002053	Spring - Battery	1-10294	34160
	9002056	Link - Battery Box	1-10297	
	1410-4	No. 4 Terminal Lug	F.S.	83330
	AD42ABS	Rivet - Pop	F.S.	USM Corp.
	2160	Washer Flat No. 8	F.S.	83330

Table 6-13. Parts List (Front Panel CRT Sub-Assembly PS920)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9002013	Panel - Front Readout		34160
	9002015	Bracket - CRT	1-10275	34160
	9002049	Spacer - Filter	1-10287	34160
	9003008	Graticule	2-60001	34160
	9002055	Protector - Face Plate	4-20039	34160
	C17370-012-4	Clip, 4-40	4-20013	78553
	MS35649-44	Nut, 4-40	F.S.	
	MS35333-36	Washer, Int. Lock, 4-40	F.S.	

Table 6-14. Parts List (Front Panel Sub-Assembly PS920)

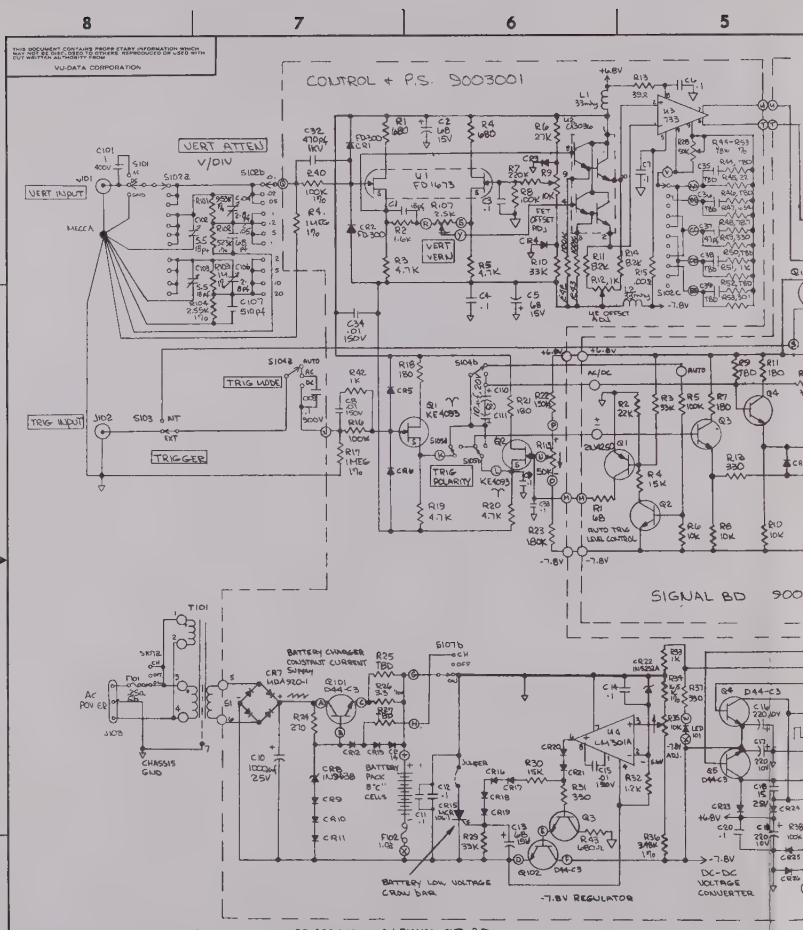
REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9002006	Panel - Front Control		34160
	9002034	Panel Controls	1-10284	34160
	9005006	Switch - Horiz. Sub-Assy.		34160
	9005005	Switch - Vert. Sub-Assy.		34160
R113	MLC54L	Res. Var. 50K Carbon	5-78503	Mallory
S103	7101	Switch - Toggle SPDT	2-10003	C & K
S107	7203	Switch - Toggle DPDT	2-10016	C & K
S101,104	7211	Switch - Toggle DPDT	2-10002	C & K
S105	7201	Switch - Toggle DPDT	2-10015	C & K
J101,102	31-221-1015	Conn. BNC Pnl UG1094/U	2-28998	Bendix
LED101	MV5023	Power Indicator LED,RED	3-15023	Monsanto
	023-352	Knob - Black	4-10013	Elma
	021-123	Knob - Red	4-10009	Elma
	021-222	Knob - Black	4-10011	Elma
	040-103	Cap - Red	4-10010	Elma
	040-103	Cap - Black	4-10012	Elma
	C17270-012-4	Clip, 4-40	4-20013	78553
	MS35649-44	Nut, 4-40	F.S.	
	MS35333-36	Washer Int. Lk 4-40	F.S.	
	1497	Solder Lug 3/8 ID	F.S.	83330
	8482	AL Spacer .250 x .375 Long	4-20045	83330
C101	625B1E104K	Cap.Mylar .1uf,400V ±10%	6-59104	14752
C110,111	T360B106M020S	Cap.Tant 10uf, 20V ±20%	6-71106	05397
C109	5GA-P10	Cap.CD .1uf, 500V ±20%	6-29103	56289

Table 6-15. Parts List (Oscilloscope Final Assembly PS920)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	9005001	Control Bd. Sub-Assy.		34160
	9005011	Front Panel Sub-Assy.		34160
	9005009	Battery Box Assy.		34160
	9005002	Signal Bd. Sub-Assy.		34160
	9005008	High Voltage Cont. Sub-Assy.		34160
	9005007	Position Cont. Sub-Assy.		34160
	9005010	Front Panel CRT Sub-Assy.		34160
	9002016	Shield - Transformer	1-10269	34160
	9002011	Panel Left Side	1-10274	34160
	9002051	Cover - Battery	1-20036	34160
	9002047	Transformer	7-61006	34160
	9002009	Spacer	1-10273	34160
	9002046	Transformer DC-DC Conv.	7-61005	34160
	9002004	Panel - Right Side	1-10272	34160
	9002014	Panel Rear, Left		34160
	9002005	Panel Rear, Right		34160
	9002010	Bracket, Fuse Holder	1-10288	34160
	9002019	Support PC Board	1-10276	34160
	9002052	Angle - Cover	1-10293	34160
	9002028	Shield - Switch	1-10278	34160
	9002058	Cover - Top		34160
	9002059	Cover - Bottom		34160
	9002027	Cover - Side		34160
	9003007	Label - ID	4-20042	34160
	9002045	Coil - Trace Angle	5-90003	34160
	2122001	CRT Shield	1-10100	34160
	3GBP31	CRT	3-40001	80368
	EAC-301	Conn.-Receptacle		Switchcraft
	2342	Spacer 1/4 x 3/8L 4-40 THD	4-20043	83330
	HMM	Fuse Holder	2-40007	Buss
	3AG 1A	Fuse 1A	2-40009	Buss
	3AG .25ASB	Fuse 1/4A SB	2-40004	Buss
	G3-1000-101	Test Jack - White	2-50009	83330
	4521-22-30-1C	Clip - Fuse	2-40010	Sea Strom
	D44-C3	Trans NPN Pwr	3-244C3	GE

Table 6-15. Parts List (Oscilloscope Final Assembly PS920) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
	021-222	Knob - Black	4-10011	Elma
	040-103	Knob Cap - Black	4-10012	Elma
		Clip Anode	F.S.	
	F4B	Feet, Cabinet	4-20037	Budwig
	DF103C	Mica Insulator		86684
	DF137A	Washer Insulating		86684
		Fender Washer 1 3/8 OD; 1/4 ID x 1/16		Handyman
	MS51957-17	Screw, Pan 4-40 x 1/2		
	MS35333-36	Washer, Int Lk 4-40		
	MS35649-44	Nut - 4-40		
	MS24693-2	Screw 100°, 4-40 x 1/4		
	MS51957-19	Screw Pan 4-40 x 3/4		
	MS51957-20	Screw Pan 4-40 x 7/8		
	MS51957-15	Screw Pan 4-40 x 3/8		


THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF VU-DATA CORPORATION. ANY REPRODUCTION OR USE WITH OUT WRITTEN AUTHORITY FROM VU-DATA CORPORATION
CONTROL & P.S. 9003001
SIGNAL BD 900
VERT ATTEN V/DIV
VERT INPUT
TRIG MODE
TRIG INPUT
TRIGGER
BATTERY CHARGER CONSTANT CURRENT
BATTERY PACK 8 CELLS
BATTERY LOW VOLTAGE CRKT BRD
-7.8V REGULATOR
DC-DC VOLTAGE CONVERTER
CHASSIS GND
AC POWER
NOTES UNLESS OTHERWISE SPECIFIED
10. 300 SERIES DESIGNATORS ARE MOUNTED ON SIGNAL CKT. BD.
9. 200 SERIES DESIGNATORS ARE MOUNTED ON CONTROL & PS CKT BD.
8. ▽ INDICATES ΔVgs MATCHINGS TO ΔV IN AT CIRCUIT ID
7. # INDICATES MATCHED TO ±1%
6. ALL 1% RESISTORS ARE ¼W
5. 100 SERIES DESIGNATORS ARE MOUNTED OFF CKT. BD.
4. ALL DIODES ARE 1N3914
3. ALL TRANSISTORS ARE 2N3694
2. ALL CAPACITORS ARE IN MFD, ±1 ARE 20V
1. ALL RESISTORS ARE ¼W, 5%

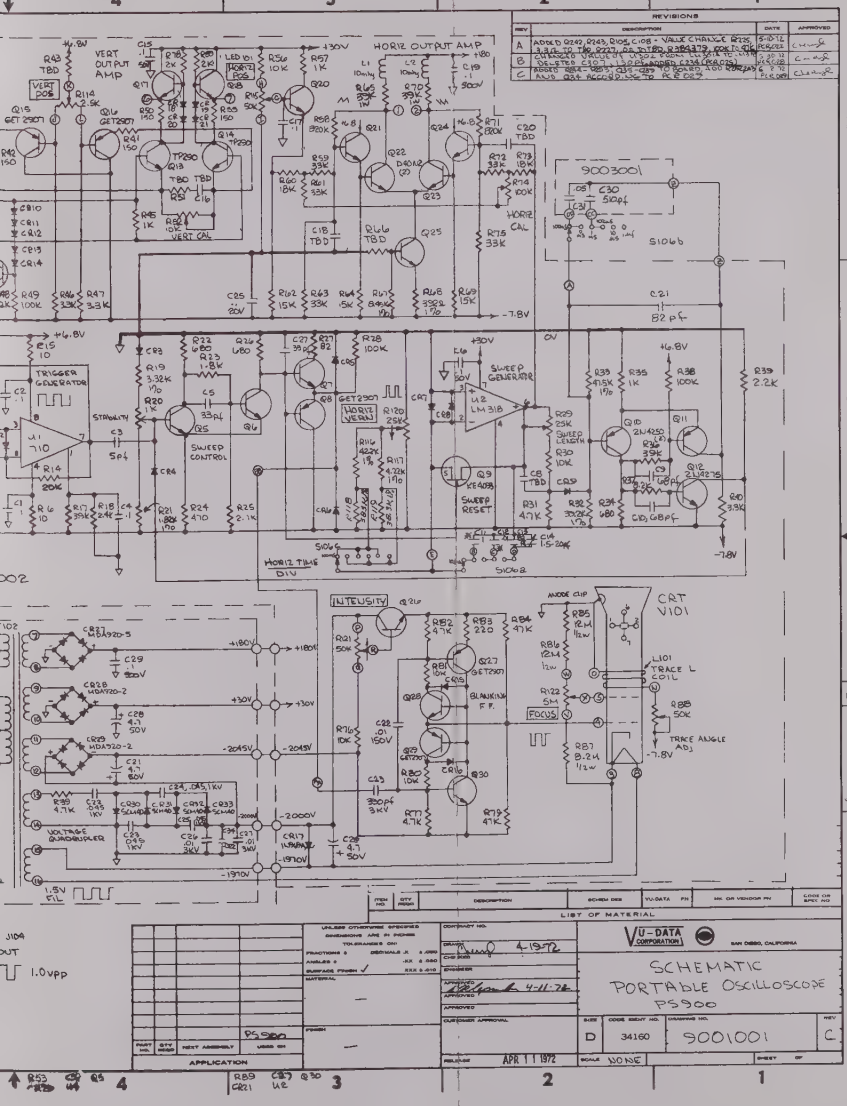
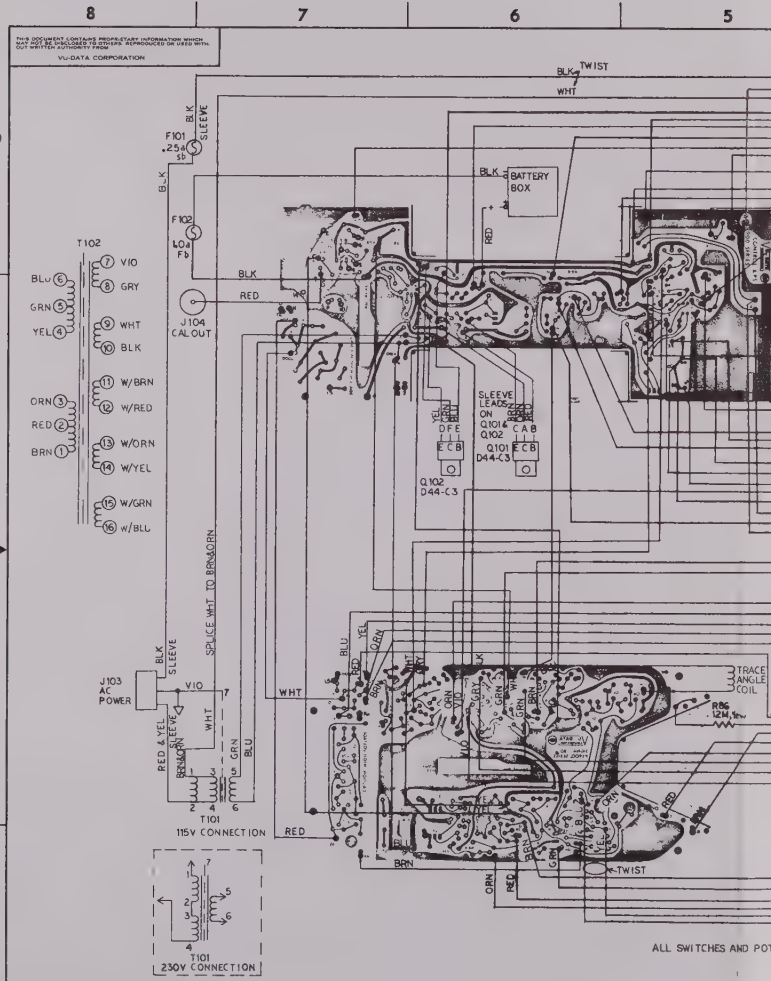


Figure 7-1. Series PS900 Schematic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F101
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SB
SLEEVE
BLK
F102
1.0A
FB
T102
VIO
GRY
WHT
BLK
W/BRN
W/RED
W/ORN
W/YEL
W/GRN
W/BLU
BLU 6
GRN 5
YEL 4
ORN 3
RED 2
BRN 1
7
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12
13
14
15
16
J104
CAL OUT
BLK
RED
BATTERY
BOX
SLEEVE
LEADS
ON
Q101 &
Q102
Q101
D44-C3
Q102
D44-C3
E C B
D F E
C A B
SPLICE WHT TO BRN/ORN
J103
AC
POWER
VIO
BLK
SLEEVE
RED & YEL
BRN
SLEEVE
WHT
GRN
BLU
T101
115V CONNECTION
T101
230V CONNECTION
TRACE
ANGLE
COIL
R86
12W 1%
TWIST
ALL SWITCHES AND POT

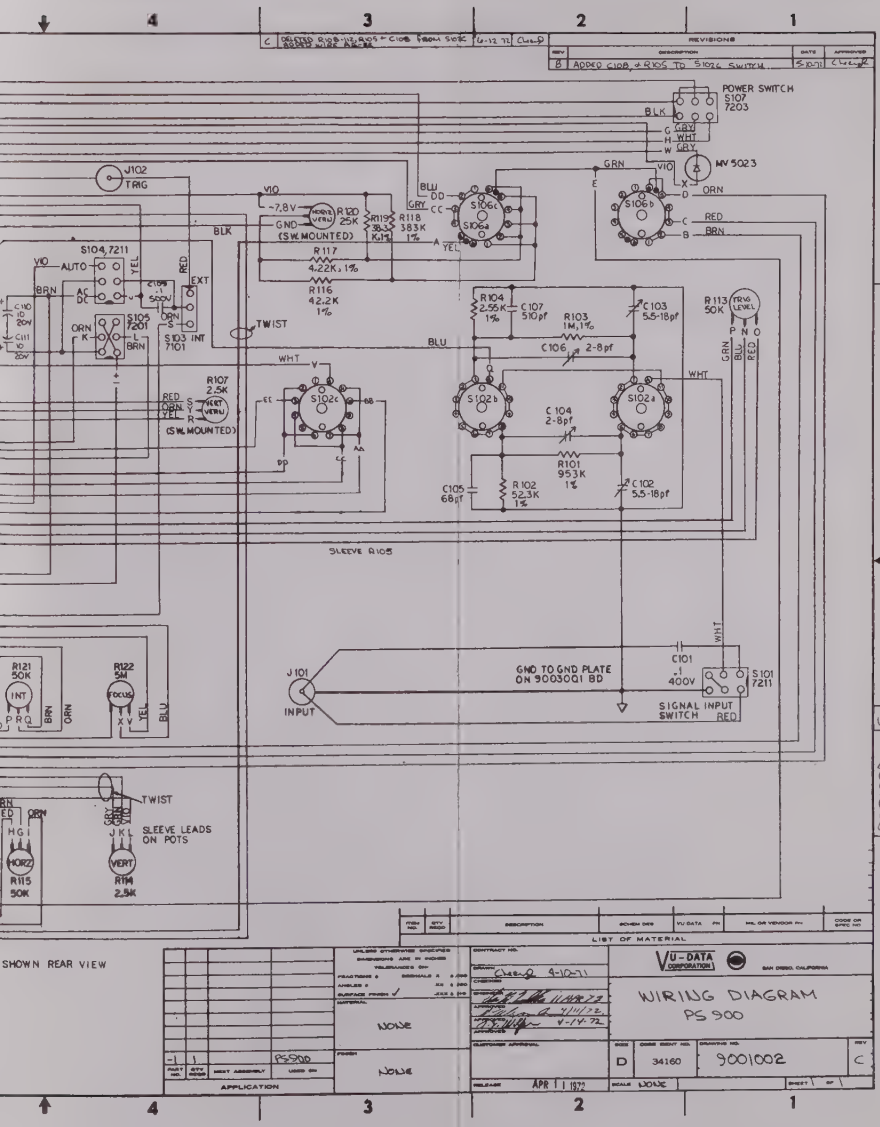

Figure 7-2. Series PS900 Wiring Diagram

SECTION VIII

RECOMMENDED SPARES

The following is a list of recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance of one year in an isolated area.

ASSEMBLY OR PART NAME		PART NUMBER	QUANTITY OF PARTS		
			1 Inst.	5 Inst.	10 Inst.
CRT Assembly	3B6-P31	3-40001	1	1	3
Power Cord (920)	SPH-386	2-70005	1	1	1
Power Cord (910)	17258	1-70004	1	1	1
I.C., Dual FET	FD1673	3-21673	0	1	2
I.C. Amp.	LM301A	3-30301	0	1	2
I.C. Amp.	CA3036	3-33036	0	1	2
Diode, SCR	MCR106-1	3-10106	0	1	2
Diode, Bridge	MDA920-2	3-19202	0	1	2
Transistor, NPN-Power	D44C3	3-244C3	0	1	2
Transistor, FETS Matched	KE4093	3-21837	1 Pr.	2 Pr.	3 Pr.
Transistor, NPN, Signal	2N3694	3-23694	1	2	3
Diode, Gen. Purpose	FD300	3-10300	0	1	2
I.C. Amp.	LM318	3-30318	0	1	2
Transistor, NPN, Signal	2N4275	3-24275	0	1	2
Transistor, NPN Power	D40N2	3-240N2	0	1	2
Transistor, NPN-Signal	TP290	3-22369	0	0	1
Transformer	9002047	7-61006	0	0	1
Transformer	9002046	7-61005	0	0	1
Fuse	3AG1A	2-40009	3	5	10
Fuse	3AG25ASB	2-40004	1	2	5
Batteries	2.0 SCB	4-20036	8	16	24

MODEL NUMBER_____ SERIAL NUMBER_____

WARRANTY

VU-DATA CORPORATION hereby warrants to each original purchaser of all instruments of Vu-data Corporation manufacture as follows:

I. At the time of delivery of all instruments to the original purchaser thereof, Vu-data Corporation UNCONDITIONALLY WARRANTS that all of such instruments shall be free from defects in parts, materials, and workmanship; and

II. Commencing with the date of delivery of all instruments to the original purchaser thereof, which delivery date for purposes of this warranty shall be deemed to be Vu-data Corporation's original shipment date, AND FOR A PERIOD EXPIRING ONE (1) YEAR FROM SAID DATE, Vu-data Corporation UNCONDITIONALLY WARRANTS that all such instruments shall remain free from defects in parts, materials, and workmanship.

In the event any instrument shall fail to meet the terms of this warranty, Vu-data Corporation agrees that if the original purchaser of any such instrument shall:

(1) Give to Vu-data Corporation's customer service department prompt notice in writing of the nature of any suspected defect; and

(2) Upon receipt of written authorization and shipping instructions from Vu-data Corporation, return the instrument with suspected defects, transportation charges prepaid, to Vu-data Corporation's main plant located in San Diego, California; then Vu-data Corporation shall replace any and all defective parts/materials and shall repair any and all defective workmanship and shall return the instrument, TRANSPORTATION CHARGES COLLECT, in good working order and state of repair to the original purchaser thereof, or in the alternative, Vu-data Corporation shall have the option to replace any such defective instrument by substituting a new instrument of the same type therefor, ALL WITHOUT ANY CHARGE WHATSOEVER:

The warranties herein contained shall not obligate Vu-data Corporation in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection of the instrument by Vu-data Corporation are not to Vu-data Corporation's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship.

Vu-data Corporation reserves the right to modify or change the design or appearance of any of its instruments as it deems desirable. Nothing herein contained shall preclude such right or create any obligation to effect such changes on units previously purchased.

The remedies herein specified in the event of a breach of any of the warranties herein contained shall be the sole and exlusive remedies for such breach.

The warranties herein contained are intended to be and shall be construed as being in addition to and cumulative to all implied warranties contained in the Uniform Commercial Code, provided, however, that in the event of any breach by Vu-data Corporation of any of the implied warranties contained in the Uniform Commercial Code neither the purchaser of any Vu-data Corporation product, nor any other person, shall be entitled to recover by reason of such breach any incidental damages or consequential damages as those terms are defined in subsection 2–715 of the Uniform Commercial Code.

All warranties herein contained shall run only in favor of the original purchaser of Vu-data Corporation's instruments and all such warranties shall immediately terminate and become null and void and of no further force or effect whatsoever upon the sale or other transfer of any such instrument by the original purchaser. The warranties herein contained constitute the sole and exclusive warranties made by Vu-data Corporation of its instruments and no other express warranties not herein contained are given and no affirmation of fact, promise or representation made by any agent, employee or representative of Vu-data Corporation shall constitute a warranty. No agent, employee or representative of Vu-data Corporation has any authority to bind Vu-data Corporation in any affirmation of fact, promise, representation or warranty not herein expressly contained.

The above statements and warranty constitutes a part of Vu-data Corporation's standard Terms and Conditions of Sale as published in our Order Acknowledgement which together is Vu-data Corporation's warranty in its entirety.